ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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BIDS FOR STEEL PIPE in large quantities are to be received at Perth, Western Australia, on Aug. 23, by the government of the country named. The pipe is to be used for the Coolgardie pipe line, described in our issue of Feb. 10, 1897, and discussed editorially in our succeeding issue. There are to be 246 miles of 31-in. riveted and 82 miles of 26 to 29-in. welded pipe. Drawings, specifications and forms of contract may be obtained in this country, on payment of two guineas (about $10), from Messrs. Seward, Guthrie & Steele, 40 Wall St., New York city. Mr. C. Y. O'Connor, M. Inst. C. E., is Engineer-in-Chief of the Public Works Department, and his office is at Perth, Western Australia.

THE INTERNATIONAL ASSOCIATION FOR TESTING materials, at the Stockholm Congress of 1897, declared it expedient that the members of the Association resident in any one country organize themselves into a body for better carrying out the purposes of the Association and simplifying matters of correspondence and finance. A call is now issued for the purpose of effecting the organization of the American Section, at Philadelphia, June 16. Mr. Gus C. Henning, M. Am. Soc. M. E., and Member of the Council of the Association, has been appointed the provisional American representative of the Association, and all communications should be addressed to him at 220 Broadway, New York city. The meeting will be held at the home of the Engineers' Club of Philadelphia, at 7 p. m.

THE 16-IN. COAST DEFENCE GUN, for which parts are now being made at Bethlehem, Pa., will be the most formidable piece of ordnance in the world. This gun will be mounted at the entrance to New York harbor, probably in a turtle-back turret on Romer Shoals. The designer of the gun, Mr. J. F. Meigs, figures that the striking energy of its 2,350-lb. shell propelled by 1,000 lbs. of powder, will be 60,000 ft.-tons. This is equivalent to the shock which would result from bringing a 6,000-ton steamer, running at 16 miles per hour, to a sudden stop. The estimated range of the gun is 16 miles, and the program calls for 14 of these guns mounted in the forts about New York. A comparison with the great guns of other nations would stand as follows, as taken from a table prepared by Lieut. W. H. Jaques, U. S. N., for the Select Committee on Ordnance and Warships of the U. S. Senate, and from a list made by Lieutenant Cardon:

Countries.	Caliber, ins.	Gun tons.	Length, ft.	Shell, lbs.	Powder charge, lbs.
United States (1808)	16	126	49.1	2,350	1,000
England (1883)	17	108	46.8	2,000	882
" (1884)	16.25	110	41.8	1,800	900
Italy (1880)	17.42	100	32.7	2,000	551
" (1882)	17	100	39.7	2,000	772
Germany (1890)	16.50	120	45.9	2,204	903
France (1890)	16.54	74.2	32.5	1,719.6	595

AN AUTOMATIC 1-PDR. GUN, capable of firing 180 shots per minute, is being tested at Indian Head. It is especially intended for use against torpedo boats, and its effectiveness for such a use is apparent.

A NEW BREECH-PLUG for heavy guns is being introduced by the English gunmakers, Vickers' Sons & Maxim. The breech-plug now in use is cut with a coarse thread of from 10 to 15 turns, and the inner surface of the plug-chamber in the gun is threaded in a similar manner. As it would consume too much time to turn this heavy plug, weighing nearly half a ton for a 13-in. gun, completely around ten or fifteen times, an "interrupted screw" is used. Alternate eighths of the threaded part of the plug and chamber, lengthwise of the plug, are removed, so that a rotation of one-eighth releases the plug, allows it to be slipped back on its hinged carriage and swung around out of the way of the projectile and charge. In this plug one-half of the holding power of the screw circumference is destroyed and the length must be increased. The new Vickers plug has the length of the plug divided into 12 parts, and out of every four adjacent threaded segments only one is removed. But the other three parts are graduated like steps, so that the threads are at unequal distances from the axis of the plug, or have different radii. The plug-chamber is treated in a similar manner with threaded, stepped recesses, and the result is that one-twelfth of a turn will lock or unlock the plug; and the new plug is 33% stronger than the old one and allows the weight and length of plug to be diminished in proportion. The inventor is said to be Axel Welin, a Swedish engineer.

WISE-EDDY KITES, carrying photographic apparatus, are being prepared for use in Cuban land operations. They will be used for taking photographs of the enemy's position and for making signals to distant points. The corps organized is under the command of Lieut. Hugh D. White, of the 9th Infantry, U. S. A. Flags in the daytime and electric light at night will be employed in signaling.

THE U. S. S. "BUFFALO," formerly the Brazilian dynamite cruiser "Nictheroy," is at the Norfolk Navy Yard, to undergo extensive alterations. This vessel was originally the "El Cid," of the Morgan Line of steamers, and she was built by the Cramps of Philadelphia about 1892. In October, 1893, she was bought by the Brazilian government and greatly strengthened in her decks and armed with a 15-in. dynamite gun, one 55-pdr. and two 33-pdr. rapid-fire guns, and 8 6-pdr. and 9 1-pdr. Hotchkiss guns. The length of the ship over all is 406 ft.; draft, 23 ft.; displacement, 4,666 tons; coal bunker capacity 1,000 tons, and 2,000 tons more can be carried in her hold. The "Buffalo" will be fitted with a 3 to 2-in. steel belt, and she will carry a main battery of 10 6-in. rapid-fire guns and a secondary battery of 3 and 6-pdrs. She was designed by Mr. Horace See, M. Am. Soc. M. E., then with the Cramps, and her speed was 17½ knots per hour.

THE LOCATION OF THE NEW DRY-DOCKS for the navy is in the hands of a special committee, with Admiral F. M. Ramsay as President and Peter C. Asserson, C. E., U. S. N., and a Naval Constructor, as members. This committee has gone to Galveston to investigate the sites proposed for the floating dry-dock; but the probabilities are that this will be placed at Algiers, opposite New Orleans. This steel floating dock will be built in the North and towed to its position; it will be designed to take a 15,000-ton warship, and will cost at least $700,000. The only concrete dock will be the one at Boston, Mass.; and the docks at Portsmouth, N. H., League Island, Pa., and Mare Island, Cal., will all be timber structures. All of these docks will be 700 ft. long and have a depth over the sill of not less than 27 ft. The estimated cost of the concrete dock is $1,200,000, and that of the timber docks $700,000 each.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Sedgwick, Colo., on the Union Pacific, Denver & Gulf Ry., on June 2, in which six persons were injured. It is understood that the train was running on schedule time at about 40 miles per hour, when the front truck of the leading car jumped the track, causing the entire train, with the exception of the engine, to leave the rails.

A DISASTROUS FIRE at Peshawur, India, is reported to have destroyed 4,000 houses, causing a loss of $20,000,000. The town is on the border of Afghanistan, opposite the mouth of the Khyber Pass, and is the capital of a district of the same name in the Punjaub. Its population, since it became a British military station, is given as 85,000.

A BREAK IN THE FEEDER for the Black River Canal at Forestport, N. Y., on May 25, carried away about 400 ft. of wall. It is estimated that the repairs will cost between $50,000 and $60,000, the work being pushed day and night.

SUEZ CANAL TRAFFIC, for 1897, declined 660,910 tons, as compared with 1896, and was 549,010 tons below the traffic of 1895. The revenue from tolls fell proportionately from $15,913,999 in 1896, to $14,566,109 in 1897. The number of vessels passing through the canal was 3,434 in 1895, 3,409 in 1896, and 2,986 in 1897. The number of passengers carried on ships going through the canal has increased. In 1870 this number was 26,758; in 1880 it was 98,900; in 1890, 161,352, and in 1897, 191,224.

THE LAKE MICHIGAN-LAKE ERIE SHIP CANAL project is again revived and a bill appropriating $3,000,000 for construction has been introduced into Congress by Representative J. H. Southard. The line proposed would extend from Benton Harbor, on Lake Michigan, to the Maumee River and Toledo, on Lake Erie. The length of the canal would be about 156 miles, and it would save about 1,000 miles in navigation between the two lakes. The navigation season would also be lengthened about five weeks. The Illinois and the Maumee rivers would have to be rectified and deepened and 87 miles of canal cut. The estimated cost is $14,000,000; but the argument of Congressman Southard makes no mention of the difference in level to be overcome along the route.

A HEAVY COAL TRAIN, recently hauled over the Chicago & Eastern Illinois R. R., was made up of 55 cars of 80,000 lbs. capacity, each car being fully loaded. It was hauled at an average speed of 20 miles per hour from Danville to the Chicago freight yards, 106 miles, by one of the new consolidation engines. The engine has cylinders 21 × 26 ins.; driving wheels, 4 ft. 6 ins. diameter; driving wheel base, 15 ft. 6 ins.; total wheel base, 25 ft. 4 ins.; weight on driving wheels, 143,000 lbs. About half the distance is up grade, the maximum grade being 0.4%. The distribution of the weight was as follows:

	P. c. of total.	Lbs.
Engine and tender	4.1	268,000
Cars	27.9	1,815,000
Coal	67.6	4,400,000
Caboose	0.4	27,000
Total	100.0	6,510,000

LOCOMOTIVES FOR JAPAN, to the number of 38, are to be built by the Schenectady Locomotive Works. Of these 26 are for the Nippon Railway and 12 for the Keusheu Railway.

THE NEW EAST RIVER BRIDGE COMMISSION is to receive an amount of money, probably $2,000,000, sufficient to pay outstanding liabilities and to carry out all existing contracts. The sum asked for by the Commission, however, was over $4,000,000.

SWINGING WINDOWS above the second story on all new buildings are required by a building ordinance lately passed in Chicago. The avowed purpose of the new law is the prevention of fatal accidents in washing windows, now so frequent. The law says that the window must swing on horizontal or vertical pivots, or a balcony must be built in front of every window. The law is objected to by architects and builders, who claim that it was passed in the interest of the owners of patents on swival windows. It is also objected that the size of windows will have to be reduced owing to wind pressure, and they predict that fatal accidents will result from falling window sash. In many of the recent high office buildings of New York city a staple is secured to each side of every window opening, and the window cleaners wear stout belts, to each side of which is attached a strap. A suitable clip on the end of each strap enables it to be readily attached to the staples on either side, and the straps have slack enough to permit the free movement of the window cleaner.

LIQUID HYDROGEN has been produced in considerable quantity by Prof. Dewar, of England, who has for many years been experimenting with low temperatures and the liquefaction of gases. His latest researches were explained before the Royal Society at its last meeting. As far as can be learned at present, the process employed is similar in a general way to that used to liquefy air (Eng. News., April 14, 1898), only hydrogen gas is used instead of air. In the experiments it was found that at about — 205° C. (— 401° F.) and at a pressure of 180 atmospheres (2,650 lbs. per sq. in.) if the hydrogen were allowed to escape from a nozzle at the rate of about 10 or 15 cu. ft. per minute into a special double vacuum receiver, liquid hydrogen was formed. The liquid is clear and colorless, showing no absorption spectrum, and is the last of the known gases to be liquefied. About 1% of the gas passing through the apparatus is transformed into liquid.

A METHOD FOR DETERMINING THE FREQUENCY of alternating currents was described in a paper by Carl Kinsley, of Washington University, St. Louis, Mo., printed in the "Philosophical Magazine" for April, 1898. A long tube, about 4 cm. in diameter, with an adjustable piston, is provided at the open end, with a powerful telephone receiver placed in line with the tube and a short distance away. The alternating current is supplied to the receiver which produces a musical note whose fundamental will have the same number of vibrations that the alternating current has periods. By adjusting the plunger a point can be readily found where the note is reinforced. Knowing the length of the air column, the periodicity is easily calculable. A table is given in which temperature and moisture corrections have been made and by which the frequency may be found at once without calculation by the operator.

THE FAILURE OF THE LYNX CREEK MASONRY DAM, NEAR PRESCOTT, ARIZ.

By Jas. D. Schuyler, M. Am. Soc. C. E.*

The people of Arizona have had so many unfortunate experiences with dams of various sorts that they appear to have gotten into a state of almost unreasoning fear of all dams, and express doubts of the possibility of making any dam absolutely secure. Almost every dam or diverting weir on the Salt and Gila rivers, the two main drainage arteries of the territory, has been crippled or destroyed by floods at different times, while the

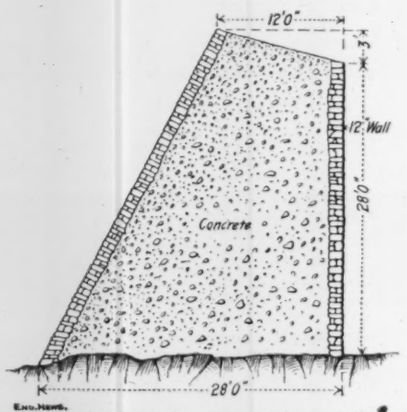


Fig. 1.—Sketch-Section of Lynx Creek Dam, near Prescott, Ariz.

only large storage reservoir dams yet constructed have failed. These repeated disasters are regarded as particularly unfortunate because of their effect in retarding the execution of other large water storage enterprises in Arizona, whose future growth and prosperity is so largely dependent upon the successful impounding of large volumes of water for irrigation. The most appalling catastrophe was the failure of the Walnut Grove dam,† on the Hassayampa River, 30 miles south of Prescott, on the night of Feb. 22, 1890, which was accompanied by the loss of 129 lives. The dam was a rock-fill, faced with plank, 110 ft. high. It was overtopped by a flood too great in volume for the capacity of the spillway, and the entire contents of the reservoir, about 4,000,000,000 gallons, were suddenly released and rushed down the 35-mile canyon in an enormous wave which swept out every vestige of habitation, vegetable growth, soil and gravel down to the bare bedrock. One remarkable effect was the brilliant glow of phosphorescent light which is said to have illuminated the progress of the flood as it advanced, rendered specially noticeable by the blackness of the night, while the horror of the event has left an equally luminous impression upon the minds of the terror-stricken eye-witnesses.

This disaster was followed a year later by the failure of the Lynx Creek masonry dam, which was in process of erection twelve miles east of Prescott, and failed with the first flood which reached its crest. It occasioned no loss of life, however, and consequently attracted little public attention, except that, being a masonry dam, its failure seemed to indicate to the layman unfamiliar with the details of the case, that even that more substantial class of construction is as subject to disaster as the rock-fill or earth dams. The writer had occasion recently to visit the site of the short-lived Lynx Creek dam, and secured some photographs which may serve to make the following notes of interest.

The dam was designed to impound water for hydraulic mining some four miles below, and was planned for a height of 50 ft. The thickness at the base was made 28 ft., and at the time of its rupture it had reached a height of 28 ft., where the top was squared off with a thickness of 12 ft., the lower edge of the crest being about 3 ft. higher than the upstream crest line, as shown by the section, Fig. 1. It was evidently intended to use the dam at that height for some time before adding the upper 22 ft. The length on the crest was about 150 ft., and at the base about 80 ft. The upstream face was intended to be vertical, although it actually overhangs a foot or more from the plumb line. It was not arched upstream, but was built with a central angle of about 165°, opposed to the direction of the current. The breach in the masonry is about 35 ft. in width, cut out almost vertically down to bedrock. The break is shown by the views, Figs. 2, 3 and 4.

The dimensions of the dam at the time of rupture were ample to withstand any overflow to be expected from the drainage area above it (which is about 30 sq. miles, from 5,500 to 7,500 ft. in altitude above sea level), had the masonry been of reasonably good quality, as the maximum depth of overflow could not have exceeded 2 ft. before the breach occurred, and was probably much less, so that the cause of failure was manifestly due to poor workmanship and unsuitable materials. As can be clearly seen from the photographs, the wall consisted of a thin facing of hand-laid masonry, not over 1 ft. thick (none of the stones weighing over 150 lbs.), the interior, or core, being filled in with a concrete of fine gravel, quarry spawls and sand. While the facing walls were laid up in Portland cement and show a fairly good quality of mortar, the concrete core was evidently mixed very weak, and with a considerable proportion of lime, of which several barrels are still in evidence on the banks. It is said to have been mixed very soft, and was put in so rapidly as to cause the bulging of the upper facing wall out of plumb, and necessitate the shoring of the wall with heavy timbers until the concrete "set," or dried out. The concrete can be crumbled with the fingers, and one may dig holes in it anywhere with a lead pencil, or scrape a hole several inches deep in the top of the wall with one's boot.

As soon as the breach occurred the fault was attributed to the inferior quality of the cement used, of which 420 bbls. of White Bros.' English Portland cement were put into the work, and the Lynx Creek Gold Co., owners of the dam, immediately began an action for $40,000 damages against the local merchants who supplied the cement, claiming that it was part of a lot of damaged cement alleged to have been reground in San Diego, after having been wet at sea and partially set, and in that condition placed on the market. The case was tried, but the jury disagreed, nine being for the defendants, and it is still pending the settlement of the costs, although not likely to be tried again.

The engineer states that the cement was not tested prior to using, which is the essential safeguard against inferior materials in all important works, while the fact that but 420 bbls. of cement in all were used in a structure containing some 2,500 cu. yds. of volume would seem to indicate a most unusual economy of material in an overfall dam built across a mountain torrent. The cement used would average but 1 bbl. to 6 cu. yds. of masonry, a mixture of one part of cement to 35 of aggregates! Deducting the cement probably used in the facing walls, the outlet culvert and the two derrick piers in the heart of the wall now visible on each side of the break, the remainder must have made an average mixture very considerably weaker, or, say, one of cement to fifty of aggregates! The reader may judge of what strength could be expected in a wall in which even the best of cement had been so sparingly used. The fact that the facing wall had been stripped almost entirely from the lower side of the dam proves that water ran over it for some time across its entire length before it was breached in the center.

The site of the dam is an excellent one for a structure of much greater height than the one erected, as the porphyry bedrock on sides and bottom is all that could have been desired. The reservoir basin is of sufficient capacity to render a high dam worth considering for impounding water for irrigation in Lonesome Valley, a few miles beyond the hydraulic mines, where the land is of good quality for agricultural purposes.

When the facts are known, the failure of neither the Walnut Grove nor the Lynx Creek dams can be regarded as valid arguments against properly constructed dams, although conveying striking lessons of the necessity of the most minute attention to details in the erection of works to withstand the pressure or the erosive action of water. When these examples are cited it is desirable that all the circumstances and facts connected with their construction should be known, and it is solely with the object of adding a mite to the general information on the subject that the writer has submitted these notes of what, to him, was an interesting and instructive piece of dam-making construction.

FIG. 2.—BREAK IN LYNX CREEK DAM, LOOKING UP-STREAM.

*Stimson Block, Los Angeles, Cal.

†An illustrated description of this structure was given in Engineering News of Oct. 20, 1888, information regarding it by Mr. Schuyler also having appeared on Sept. 22 preceding, in some notes on rock-fill dams. In our issues of March 1 and 8, and April 5 and 26, 1890, the failure of the dam was described and discussed both editorially and by correspondents.—Ed.

AMERICAN TENDERS FOR THE IMPERIAL GOVERNMENT RAILWAYS OF JAPAN.

(With full-page plate.)

The somewhat novel style of six-wheel tender shown on the inset sheet in this issue is used with some eight-wheel passenger locomotives recently built for the Imperial Government Railways of Japan, and illustrated in our issue of Feb. 3. The engines are of the standard Japanese gage of 3 ft. 6 ins., and the tenders are 15 ft. 6 ins. long over all, mounted on six 36-in. wheels with a wheelbase of 9 ft. 10 ins. They carry 5 tons of coal and 2,400 gallons of water, and their loaded weight is 52,000 lbs. The engines and tenders were built by the Brooks Locomotive Works, of Dunkirk, N. Y.

Six-wheel tenders are used almost exclusively in European and many other countries, and are beginning to be introduced in this country, but the special feature of the tenders in question is in the construction of the frames. Ordinarily, tenders of this type have two deep plate frames, each consisting of a steel plate the full depth from bottom of tank to bottom of pedestals, the plate being slotted for the axle boxes and having portions of the web cut away between these slots so as to lighten the web, leaving, however, a top and bottom member. This general style of construction was shown in our issue of Dec. 5, 1895. In these tenders for Japan, however, a steel underframing is used, very similar to that used on many American tenders, and the axle boxes are carried in pedestals closely resembling those of the M. C. B. pattern used on car trucks, but of heavier construction. The width over the pedestals is 5 ft. 4 ins., and the lower ends of the pedestals are connected by an angle iron 3 × 4 ins.

The underframe is 15 ft. 6 ins. long, and 7 ft. 6 ins. wide, with six longitudinal sills. The center sills, 1 ft. 9 ins. apart, are steel Z-bars, 6 × 3⅝ ins., and the side sills (directly over the boxes) are steel channels 13 × 4 ins., while outside of these are angle irons 3 × 4½ ins. The end sills are 13-in. channels, and transverse Z-bars (resting on top of the center sills) connect the side sills. Over the framing is a ⅜-in. deck plating, independent of the tank. Over each axle box is a plate spring, the ends of which bear against lugs attached to the underside of the top flanges of the side sills, while the bottom of the strap of the spring has a recess fitting over the top of the bar ⅞ × 2¾ ins., which has a broad foot resting on top of the axle box. The wheels have steel tires 5¼ ins. wide, set 3 ft. 2⅞ ins. back to back of flanges. The axles are 5⅜ ins. diameter in the wheel seat and have journals 4¼ × 8 ins., the distance c. to c. of journals being 5 ft. 0.½ in.

The tank is 14 ft. 6 ins. long and 7 ft. 4½ ins. wide, built up of plates 3-16-in. and ¼-in. thick.

A specially interesting feature is the arrangement of the coupler and buffers between the engine and tender. As shown in the plan of the framing, Fig. 1, and in the detail drawing, Fig. 2, there are two 2½-in. buffer rods, which have enlarged ends bearing against seats on the 10-in. channel at the back of the engine frame. The back ends of these rods have grooved heads fitting the ends of a horizontal plate spring, which is given an initial set when the engine and tender are coupled together, so that the buffer heads are kept pressed home against their bearings as the engine and tender pass round curves, etc. The coupler is a bar 3 × 2¼ ins., with enlarged ends which fit in sockets in heavy draft castings. A 3-in. hole receives a 2½-in. pin in the engine casting, while the opposite end has a slotted hole for a similar pin in the tender casting. There are also two auxiliary coupling bars, 1½ ins. diameter. These have circular holes for 1½-in. pins in the tender casting, while the other ends are formed in loops ¾ × 8 ins. which embrace 1⅝-in. pins in the engine casting. The metal in the loops is ⅝ × 2½ ins., and it will be seen from the drawing that the loops are quite free of the engine draft pins and will not come to a bearing upon these pins unless the main coupler bar should break.

Two accessories which will attract attention are the spring buffers (of the European type) on the rear of the tender, and the unusually convenient and safe enclosed steps affording access to the tender deck. The steps are deep, and the sides prevent the foot from slipping off. These steps are of the standard form used by the builders of these engines and tenders.

THE WATER-WORKS AND FILTER PLANT OF RIPLEY, N. Y.

By E. A. Wilder, C. E.*

In 1895 the directors of the Ripley Water Supply Co. employed the writer to design and superintend the construction of a system of water-works for the village of Ripley, N. Y.

This village, with a population of 1,000, is practically on a very narrow and steep drainage area, extending parallel to the shore of Lake Erie, from Westfield, N. Y., westerly to the state line. The drainage area is about three miles in width, with a southern boundary about 700 ft. above the lake. The village is midway between the summit and the lake, at an elevation of 177 ft. Immediately south of the summit, and in places not more than 75 ft. from the Divide, is Twenty-Mile Creek, which rises near Westfield, runs westerly and parallel to Lake Erie to the state line, where it cuts through the dividing ridge and flows into Lake Erie.

It was decided to take the water from this creek at a point a little more than 1½ miles from the village, and at an elevation of 423 ft. above Main St. The general plan, shown by Fig. 1, was to collect the water from the gravel beds in the creek, conduct it through a small tunnel 700 ft. long to a storage and settling basin of 3,000,000 gallons capacity, thence through a 4-in. cast-iron pipe to a filter and distributing reservoir combined, and from there through 5,300 ft. of 8-in. main to the village. The tunnel was to be circular, 42 ins. in diameter, and lined with two rings of brick. The material through which it passed was glacial drift of every possible variety. At different times the face of the tunnel would be in hard clay, soft clay, clean, coarse gravel, and quicksand.*

The contractor commenced work on each portal in September, 1895. At the end of three weeks the writer advised using a shield, but as the foreman was an experienced miner, and had never been driven out of a heading, he was allowed to ocntinue with his methods. April 1, 1896, he abandoned the tunnel with about 180 ft. driven from each portal and three slumps extending to the surface of the ground.

The following June the work was relet to a firm of contractors from Cleveland, O., who had had considerable experience with quicksand tunnels for sewers. As no masonry had been placed in the old headings the line of the tunnel was moved upstream to avoid the slumps. Work was begun about July 1, and again there was trouble at the start with the quicksand, but they managed to overcome the difficulty by hand-driving until they were in 125 ft. at the south end and about 160 at the north. There they struck quicksand pockets that effectually stopped further progress with that method of driving.

About Sept. 10 work was suspended with a slump at the face of each heading extending to the surface of the ground. At this time the question came up as to the best appliance to use to complete the tunnel. The contractors advocated compressed air.

*Of Fredonia, N. Y.

*These various qualities of material were often encountered at the face of the tunnel at the same time.

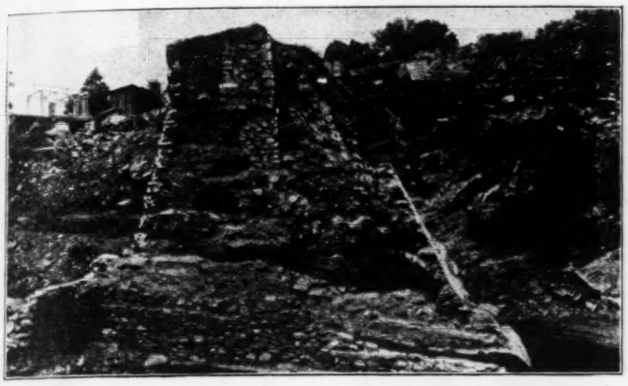


FIG. 3.—BREAK LOOKING WEST, SHOWING REMAINS OF OUTLET CULVERT AND PIPE AND PORTION OF FACE WALL.

FIG 4.—FRAGMENT OF LOWER FACE WALL IN PLACE, SHOWING CHARACTER OF MASONRY.

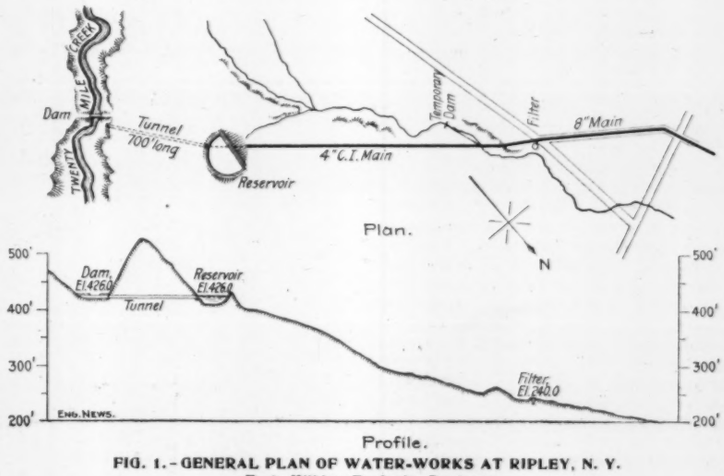


FIG. 1.—GENERAL PLAN OF WATER-WORKS AT RIPLEY, N. Y.
E. A. Wilder Fredonia, Engineer.

The writer objected strongly at a meeting of the board of directors to installing such a plant, claiming there was free drainage for the comparatively small amount of water encountered, and that a shield could be placed and operated at a much less expense. As the contractors had never used a shield, and the engineer they consulted in Cleveland advised compressed air, a plant was installed.

About Oct. 15 work was resumed. After driving about 6 ft. and just getting through the soft material of the slump, the air broke through a stratum of gravel and about 25 ft. of the tunnel filled with quicksand; not with a sudden rush, but rather a crawling that was irresistible, burying a car and some of the tools at the face and decreasing in velocity as the tunnel filled. A bulkhead of brick was then put in and a detour of 30 ft. made to get around the slump, which was successfully accomplished. From that time until Jan. 15, 1897, the work progressed without serious drawback. From 5 to 10 lbs. pressure was all that was required to keep the water out, but there was great difficulty in holding this pressure. The air passed through and around the brickwork at the face and then back through the back-filling to some stratum of gravel. While there was no serious obstacle encountered, the progress was very slow, a little less than 400 ft. being driven from Nov. 1 to Jan. 15, working day and night shifts.

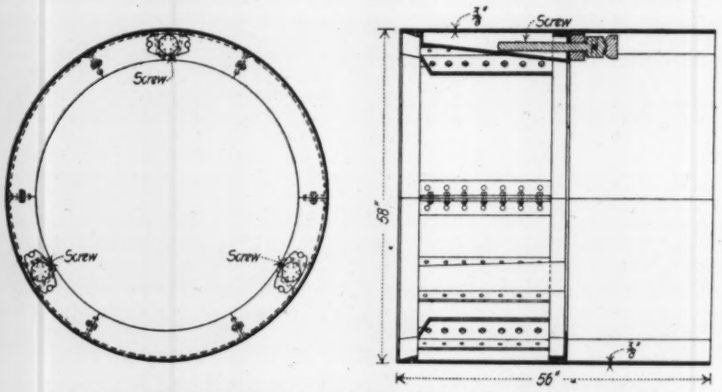


FIG. 2.—TUNNEL SHIELD DRIVEN BY SCREW JACKS, USED AT RIPLEY, N. Y.

About the latter date, with the headings 60 ft. apart, it was found to be impossible to hold the air or make further progress. A bulkhead of timber was placed at the face of the heading and the entire compressed air plant shipped back to Cleveland, the intention being to finish the tunnel by an open cut. The writer was in St. Louis at the time, but on his return demonstrated to the contractors that an open cut varying from 35 to 65 ft. in depth was more expensive than a shield, and they finally concluded to try the latter.

With a comparatively small amount of tunnel to be driven it was desirable to install a plant with the smallest possible outlay, consistent with effective work. With this object in view the writer designed a shield, as shown by the accompanying sketch, Fig. 2. Hydraulic jacks would require a steam boiler and pumps for which there was no other use, so steel screws, 1½ × 16 ins. were substituted. Brass nuts were used with a convex bearing, seated on a thin concave plate and bolted to the circular flange, or angle iron, but not rigidly. This arrangement held the screws always in place, and at the same time permitted the slight movement of the nut, necessary for adjustment, to prevent the binding of the screw. The pockets that enclosed the screws answered the double purpose of brackets, transmitting the thrust of the screw to the cutting edge and, as the seams and joints were calked,, preventing sand and mud from coming in contact with the screws.

In the shield as actually constructed all angle irons were 3 × 4 ins., and all material ⅝-in. in thickness. The circular angles were cut away entirely for the pockets for the screws. This caused a slight flattening of the shield, about 1¼ ins., which I think would have been prevented had the circular angle been 3 × 5 × ½-ins. and a 2-in. perforation made for the screw instead of cutting the iron entirely away. The writer would also advise having one screw cut with a left-hand thread for convenience in operating.

It was necessary to construct the shell of the shield in six sections in order to get it through the tunnel with its various curves to the face. This shield was built by the Erie City Iron Works, Erie, Pa., for $140 f. o. b. in Erie. It was put in place about March 18, and in eight hours the bulkhead had been taken out and the shield driven through the slump into earth that had not been disturbed. From that time until the tunnel was finished there was no hitch in handling the shield or material. The excavation through the slump at the opposite heading was made as easily as that of any other part of the work of the tunnel.

Owing to the small size of the finished tunnel it was thought best to follow the shield with timber lining rather than masonry. For this purpose sections 1-7 of a circle were cut out of 3 × 6-in. scantling, the radius of the outer circle being the same as the inside of the shield, while the inner radius was 4 ins. less, making a circular lining of timber 4 ins. thick. This proved sufficiently strong for all material through which the shield passed. However, the writer would advise cutting these sections from timber 6 × 6 ins., as there would be a less number of joints and less springing of the sections under the thrust of the jacks.

After the tunnel was driven it was finished inside of this timber lining with two rings of brick masonry, reducing the diameter of that particular part 8 ins. With the shield stopping in a pocket of quicksand its removal was out of the question so the jack screws, with the nuts, were taken out and the masonry carried through, leaving the shell as a part of the outer lining.

The collecting dam is 200 ft. long and but 3 ft. above the bottom of the creek, with a spillway 70 ft. in length. It is located at the foot of an extensive gravel bed, the top of which is a little above the crest of the dam. About 20,000 sq. ft. of this gravel bed is subdrained, and the water is conducted from the subdrains to the tunnel through an 8-in. main with a gate. The surface of the water in the reservoir at the opposite end of the tunnel is supposed to be at the same elevation as the crest of the collecting dam, 426 ft. above the village, which renders an overflow unnecessary. An advantage of this arrangement is that the clear water in the reservoir is not displaced by every flood, and the reservoir is not filled with the gravel and silt brought down by the floods. The arrangements of the pipes about the reservoir is such that water can be taken from the tunnel or reservoir or both and at the same time the waste gate can be opened to produce any desired amount of circulation.

Perhaps the only other feature of interest in connection with this system is the filter, with a normal capacity of 200,000 gallons per day. This filter is the result of several years' study and experiment on the part of the writer and is the first constructed on this principle. A distributing res-

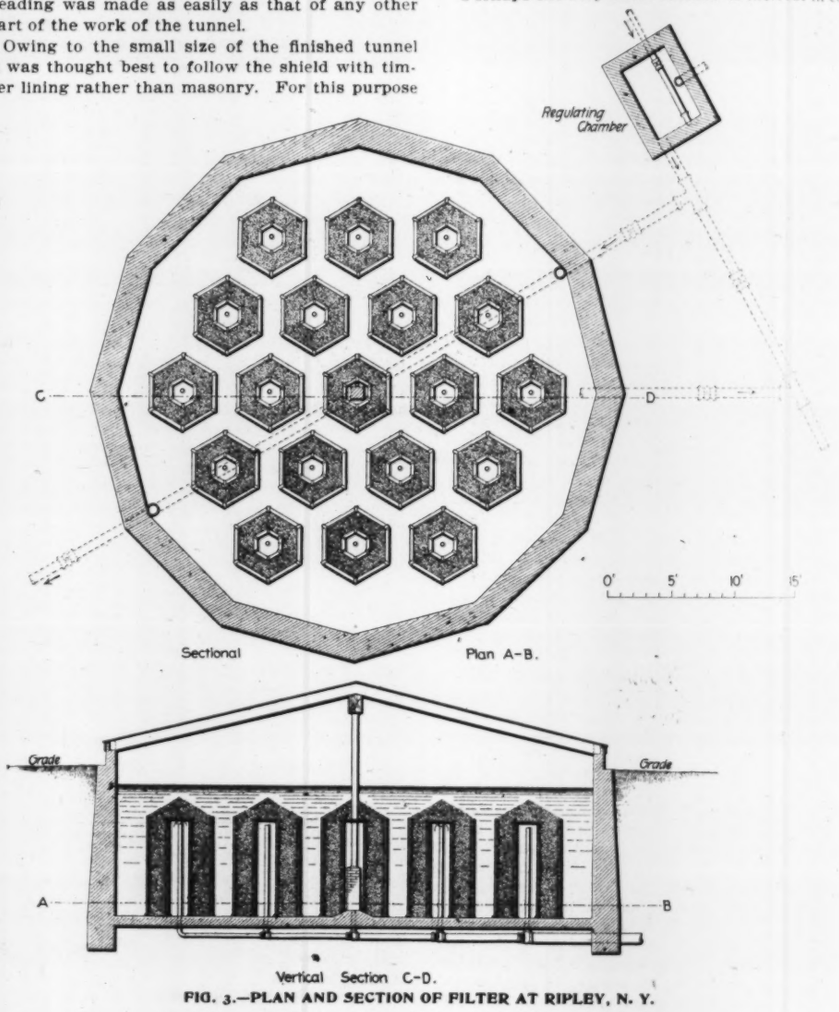


FIG. 3.—PLAN AND SECTION OF FILTER AT RIPLEY, N. Y.

ervoir was required of sufficient capacity to furnish water for four fire streams for a period of ten hours. This was located, as shown in Fig. 1, at an elevation of 240 ft. above the village. In this reservoir were placed 19 cells 8 ft. high and 6 ft. outer diameter. The inner and outer walls are open and formed of stationary slats held in place by grooves cut in the post, the slats inclining downwards and towards the opposite wall of the cell. The space or chamber surrounded by the inner wall is covered, and sand is then filled in between the two walls and over the cover, making a

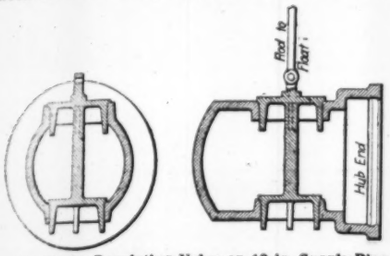


Fig. 4.—Six-in. Regulating Valve on 10-in. Supply Pipe, at Brocton, N. Y.
(A similar but smaller valve was used at Ripley.)

chamber for the filtered water entirely surrounded by sand. The water is drawn from each of these chambers through pipes to the 8-in. main leading to the village. The sand flowing out from under each slat and resting on the one immediately below forms the filtering surfaces, 3 × 36 ins., there being about 240 such surfaces to each cell.

The supply from December 1, 1895, to June 1, 1897, was from a small brook crossed by the pipe line. It was the intention not to attempt filtering this temporary supply, but to wait until the tunnel was completed. But there was so much complaint about the quality of the water that we changed our plans, putting the filter in operation in September, 1896. The first fire that occurred after the filter was started showed a weak point in this method of constructing the cells. The normal rate of filtration was calculated at 8 cu. ft. per day per sq. ft. of filtering surface, but in times of fires this rate is three or four times as great. Under these conditions the flow is concentrated immediately under the cover of the inner chamber to such an extent as to displace the sand at that point, making a funnel-shaped break in one or two cells, sufficient to relieve the balance of the filter. After a fire the water in the reservoir must be drawn down until the tops of the cells are exposed and the breaks filled with sand, when the filter is again ready to commence work, which it does in a highly satisfactory manner until the next fire. As soon as this weak point was discovered the writer designed and improved a form of cell by which the filtering surface is considerably increased and it is impossible to displace the sand or cause a break by any rate or pressure that can be produced. This cell is described below.

The filter at Ripley was in continuous operation, without cleaning, from the time it started in Sep-

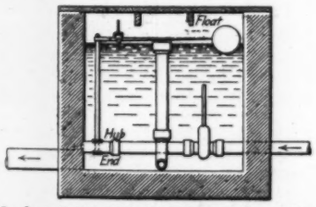


Fig. 5.—Longitudinal Section of Regulating Chamber, Ripley, N. Y.

tember, 1896, until June 1, 1897, when a change was made from the temporary to the permanent supply. This temporary supply during the Autumn and Spring months was very turbid, coming as it did, to a great extent, from cultivated fields, but the effluent was always as clear as spring water, except after fires when the breaks mentioned above occurred. In fact the condition of the supply seemed to make no difference with the effluent.

June 1, 1897, the water was drawn from the filter for the purpose of cleaning. The floor of the basin was found covered to a depth of 2 ins. or more with sediment which was scraped out, but as the accretion on the filtering surfaces was not more than 1-16-in. in depth, no attempt was made to clean them. The reservoir was filled and the filter started with a required head of 4 ins., measured at 2 p. m.

As there is no method in this plant of measuring the amount of water passing through the filter, one has to judge its efficiency entirely by appearances. To the present time of writing, the filter has been giving a clear effluent and with practically no expense for cleaning. The writer will admit the conditions for these results are exceedingly favorable, but he is convinced that with the improved form of cell satisfactory results can be obtained under the most unfavorable circumstances. The writer has been granted patents both on the above and the improved forms of filter.

To insure a constant supply of water to the filter without waste, the writer arranged an automatic regulating valve which has been in operation since Dec. 1, 1895, and has required no attention. The writer used for the village of Brocton, N. Y., a similar valve, Fig. 4, 6 ins. in diameter, in a 10-in. supply pipe, working under a 60-ft. head and with equally good results. There is no sliding of parts or friction in its action, and the demand is always in excess of any leak that is liable to occur.

The total cost of this system, including 19,000 ft. of supply and distributing mains, with 28 double fire hydrants, was about $18,000.

Experimental Filter Plant at Laona, N. Y.

The writer has an experimental filter plant on a stream in Laona, N. Y., near the village of Fredonia, constructed on the same general principles as the filter at Ripley, N. Y., but with the improved form of cell, which is reduced from 6 to 3 ft. in diameter. In place of the inner wall of slats and the inner chamber for filtered water a small core covered with brass wire gauze, as shown by Fig. 6, is used. This experimental plant consists of a full-size cell 3 ft. in diameter and 12 ft. high, with a core about 11 ft. long and 2⅜ ins. in diameter. This cell is placed in a wooden tank, 6 × 12 ft., and the water supplied from the head-race of a sawmill with the filtered water discharging into the tail race.

The stream on which this filter is placed has a minimum flow of about 500,000 gallons per day. At a point about a quarter of a mile above the plant it receives the sewage of two tanneries, each turning out about 100 sides of leather a day. The pollution of the creek is so great from this source that the influent of the filter at times is dark and of a decided red cast. At times of flood it is very turbid, and at no time is it clear. This plant was in continuous operation from the time it started, July 2, 1897, to Aug. 14, 1897, at which time it was cleaned. During this period the effluent at all times, so far as could be observed, was perfectly clear and free from color, taste, or odor. At no time would an ordinary consumer detect it from spring water. The sand used is much finer and more uniform than that in filter beds generally, and was the finest that could be obtained in this vicinity. The rate of filtration is uniformly 8 cu. ft. per day per sq. ft. of filtering surface.

The method used to clean the filter was by spraying. A brass tube 16 ins. long, with a line of perforations 1-64-in. in diameter, and spaced ¼-in. apart, connected by a ¾-in. rubber hose to the high service main, did the work. This tube was passed down and up in front of each panel with the jets inclined downward impinging against the filtering surfaces, breaking up the accretion and washing it over the edges of the slats to the bottom of the tank. The time required for washing each panel was about twelve minutes. With eight sections of tube coupled together in the form of an octagon the entire cell could have been cleaned in the same time.

In starting the filter July 2, the head required was 3½ ins. In 24 hours that had increased to 7 ins., after which the increase was slow and uniform, being 25½ ins. at the time of cleaning. After cleaning the head required at starting was 7 ins., and since that time has been increasing a little less than ½-in. daily.

From the above results the writer is inclined to think the small head of 3½ ins. was due, not so much to the sand being clean, as to its not having fully settled. The loss of head being uniform and small, both before and after cleaning, except for the first 24 hours when the filter was new, seems to justify that conclusion.

No chemical analysis of the effluent has been made, as with the large amount of sewage at times in the effluent it was a question whether the intermittent process was not necessary to produce the best results.

Owing to preventible conditions (the accidental breaking of the film on the filtering surfaces) the bacteriological analyses from July 2 to Aug. 14 were not very satisfactory, the removal varying from 88.7 to 90.1%. Since that time the analysis has shown very good results, ranging from 96.0 to

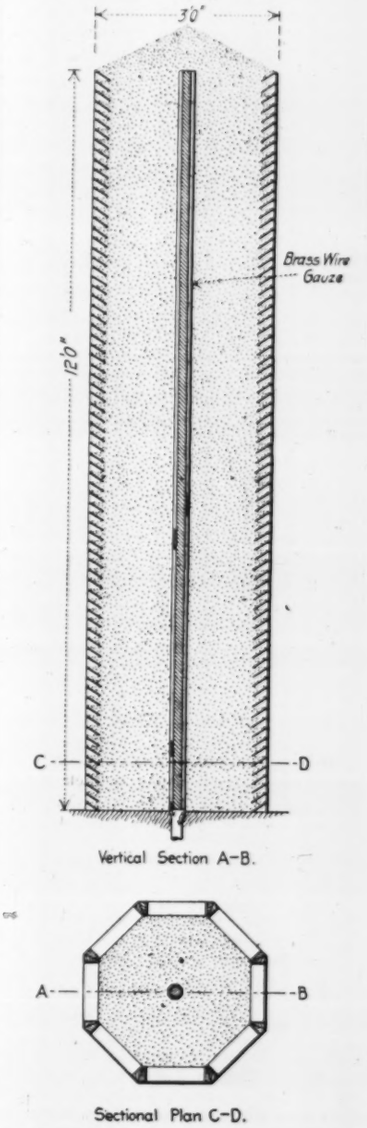


Fig. 6.—Section of Cell Used in Experimental Filter at Laona, N. Y.

99.5% removal, with a uniform rate of 8 cu. ft. per day per sq. ft. of surface. The examinations were made by Dr. T. B. Carpenter, of the Board of Health, of Buffalo, N. Y., and Dr. A. Wilson Dods, of Fredonia, N. Y.

Thirty-six of these cells can be placed in a basin or reservoir 30 ft. in diameter, giving from 3,600 to 5,400 sq. ft. of filtering surface. In large plants it would be advisable to use larger basins containing from 60 to 126 cells or more. In the construction of the cells the writer prefers the octagonal form used in the experimental plant. The cost is less and the efficiency apparently as great. It perhaps is needless to add that no coagulants have been used either with the Ripley or the Laona plants.

THE STORAGE BATTERY PLANT FOR THE CHICAGO EDISON CO.

The largest electric storage battery plant ever built has been recently installed as an addition to the lighting plant of the Chicago Edison Co., and has a capacity of 22,640 ampere-hours. It is said by Mr. T. W. Creden, the Assistant Mechanical Engineer of the company, to be about 70% larger than any other battery in the world. As noted in our issue of Feb. 17, the battery will be used principally to take care of the high peak of the large winter service, and incidentally as a means of reducing the cost of generating current. It will also ensure an uninterrupted service in the down-town district, where any interruption to the light in the stores, offices and business houses would be most disastrous.

The winter maximum in the lighting system of this down-town district has increased from 36,000 ampere-hours in 1896 to 44,000 ampere-hours in 1897, and it is estimated that with the present growth of the company's business the maximum for next winter will be about 55,000 ampere-hours. The peak of the winter load occurs about 4.45 p. m., and amounts to about 12,000 amperes for a period of ¾ to 1¼ hours. Under these conditions it became necessary to install more generating machinery or an accumulator plant. As an investment, the conditions were very favorable to the latter, the current being carried from the Harrison St. central station over a trunk line of 3,500 ft. to the company's office building at 139 Adams St. (the site of the old plant), from which point it is distributed. By placing a battery plant in the Adams St. building a large expense for trunk line conductors was avoided. Besides this, the center of load of this district is moving away from the Adams St. building, so that with feeders from 800 to 3,000 ft. long, a booster system or a large expenditure for extra feeders would be necessary to insure good regulation at the time of maximum winter load. The accumulator system installed is well adapted to meet these special requirements, as it is designed to maintain 125 volts on short feeders and 140 volts on long feeders. It is also equipped with a third end-cell switch so that another discharge voltage can be obtained should future conditions make this necessary. The battery will be constantly in circuit, floating on the circuit in the summer, and keeping the engines at the central station working at their most economical load, the battery being ready to take care of any sudden increase in load. With the battery thus kept continually in circuit there will be less necessity for regulating the pressure at the central station.

The battery has a capacity of 22,640 ampere-hours on the 8-hour rate; that is, it discharges 22,640 amperes distributed over a period of 8 hours, and can discharge 11,000 amperes for about 1¼ hours. A general view is shown in Fig. 1, while Fig. 2 shows an end view of two cells, illustrating the method of connecting the cells. There are 166 such cells, 83 cells on each side of the three-wire system. Of the total number, 60 are end cells, this large number being required to meet the wide variations of pressure, the battery being called upon to deliver 140 volts on each side at the end of discharge, and on emergency to deliver maximum current at 120 volts on each side when fully charged. The cells are 79¾ × 22⅛ ins., and 43⅞ ins. high, built of 2-in. ash and lined with 5-lb. sheet lead. Each complete cell weighs 6,200 lbs., and is supported on ten double petticoat insulators on tiles placed on the acid-proof floor. In each cell are 87 "type H" plates, 15½ × 32 ins., with positives of the Manchester type. The weight of the entire battery is 1,029,200 lbs., exclusive of the conductors. The main connections are two copper bars having an aggregate sectional area of 6 sq. ins. The end cells are connected to the end-cell switches by lead-covered copper bars ½ × 6 ins., supported by insulators on iron beams between the columns of the building, as shown in Fig. 1. This lead coating is a special feature, designed to protect the copper from the action of acid fumes and gases.

On each side of the system are three end-cell switches, each switch having 30 contact points and being able to carry 2,750 amperes. Connection between the 30 contact points and the bus-bar of the switch is effected by means of a laminated copper brush traveling on a screw which is operated by a series motor of ½-HP. Each motor is started by a push button on the switch board (shown on the right in Fig. 3), but is stopped automatically when the brush reaches the middle point on the contact block by means of an automatic device which breaks the motor circuit and short circuits the armature. This ensures the positive action of the end-cell switch without requiring the attention of the switchboard operator, and an indicator on the switchboard (operated by light gearing) keeps the operator constantly informed as to the exact position of the brush on the switch. The end-cell switches can also be operated by means of hand-wheels, and gearing is provided so that the three switches can, if necessary, be operated together, thus giving a capacity of 8,250 amperes on each side of the system. On the switchboard there are three single-pole switches for each end-cell switch, connecting the latter with either the main, auxiliary or charging bus-bars. Each panel of the switchboard has a 30-point voltmeter switch connected to a low reading voltmeter, which enables the operator to take the voltage of the end-cell switches. The switchboard is connected to the bus-bars of these switches by twelve cables, each of 1,500,000 curcular mils. Fig. 3 is a view of the distributing room at the battery station, where the various switches and instruments just described are located.

The battery will be charged during the early morning hours by current from a pair of 200-K-W. dynamos at the central station, the dynamos working at the charging pressure of 180 volts and the current being sent over a part of the trunk line to the battery station. The voltage regulation of these dynamos will be effected by an automatic control of the field resistance by means of small motors controlled by the operator at the battery station, small lead-covered cables being run from this station to the power station and connecting with the motors which control the field boxes. The two dynamos were not specially made for thus purpose, but are those of the regular station equipment, and when not used for charging they will feed into the main bus-bar of the power station. This is an important feature of the plant, as it saves an investment of about $15,000 for the boosters generally employed in battery plants, and is claimed to be a more economical method of charging than by the use of boosters.

The battery is located in the basement of the building, new footings to the columns having been put in, and everything arranged with a view to permanence, as the size of the plant and the limited area and head room would make alterations difficult and expensive. For drainage a system of 3-in. tile pipes was laid, in concrete, while for surface drainage there is a system of lead pipes laid in sand, draining several lead-lined sumps. Both systems drain into a large sump at the south end of the room, from which all drainage is pumped to the sewer by a lead-lined centrifugal pump. For a foundation, five 4-in. I-beams were laid crosswise under the cells and packed with concrete, a few layers of tarred felt being laid

FIG. 1.—STORAGE BATTERY PLANT OF THE CHICAGO EDISON CO.
(The largest battery ever built.)
Electric Storage Battery Co., Philadelphia, Pa.

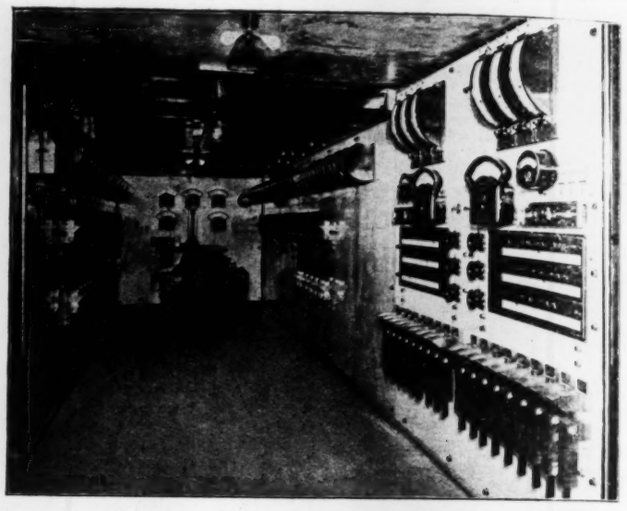


FIG. 3.—DISTRIBUTION ROOM AT BATTERY STATION, SHOWING FEEDER SWITCHBOARD AND BATTERY REGULATING SWITCHBOARD.

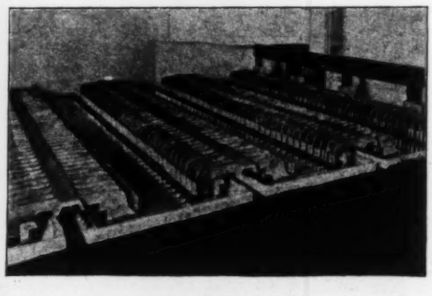


Fig. 2.—End View of Two Cells, Showing Series Connections.

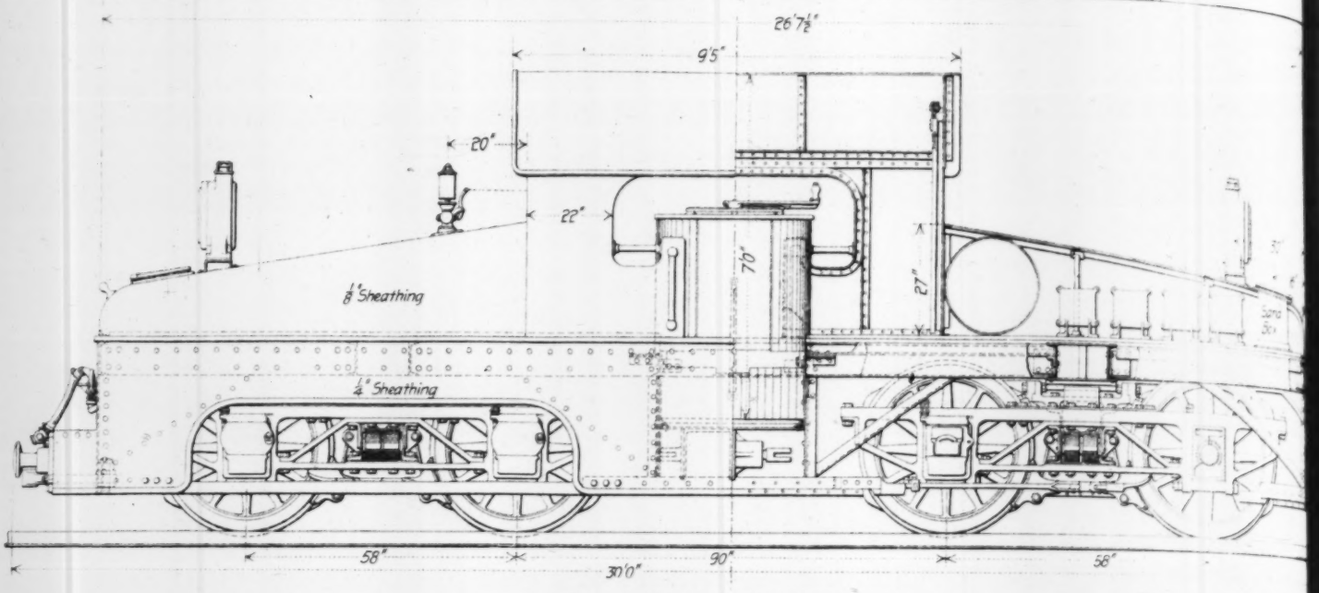


FIG. 1. SECTIONAL SIDE ELEVATION.

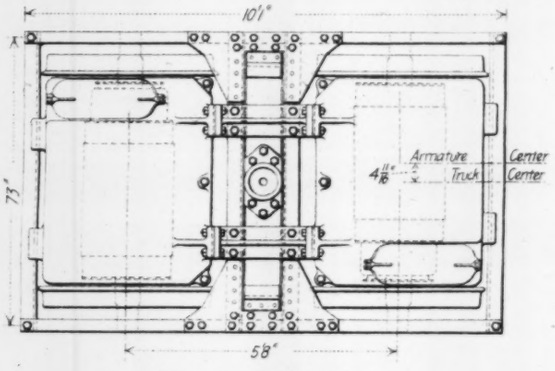


FIG. 4. PLAN OF TRUCK.

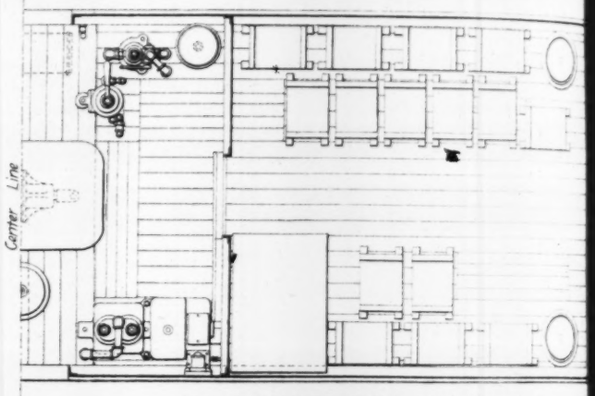


FIG. 2. HALF SECTIONAL PLAN OF CAB AND PORTION OVER TRUCKS CONTAINING RESISTANCES, ETC.

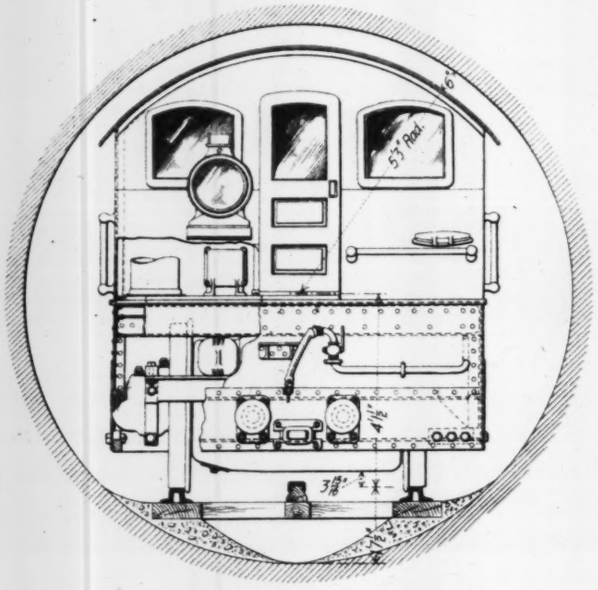


FIG. 3. END ELEVATION OF LOCOMOTIVE.

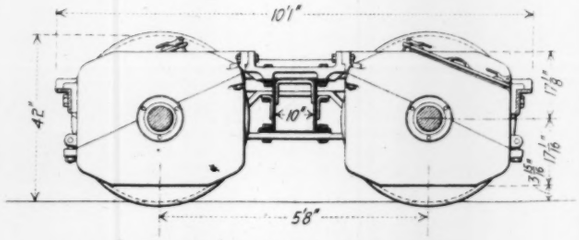


FIG. 6. SECTION OF TRUCK SHOWING RELATIVE SIZE OF MOTORS AND METHOD OF SUSPENSION.

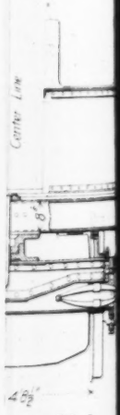


FIG. 5. HALF TRANSVERSE SE

TYPE OF ELECTRIC LOCOMOTIVE FOR THE LONDON CENTRAL UNDERGROUND RAILWAY.

General Electric Co., Schenectady, N. Y., Builders.

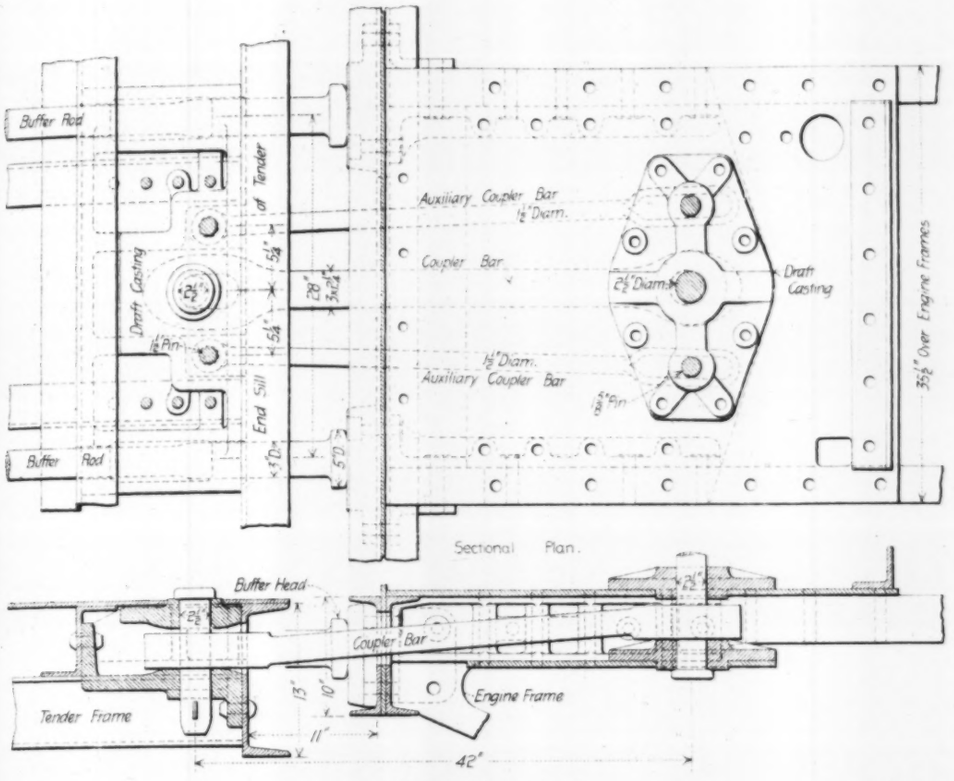


FIG. 2. ARRANGEMENT OF ENGINE AND TENDER COUPLER AND BUFFERS.

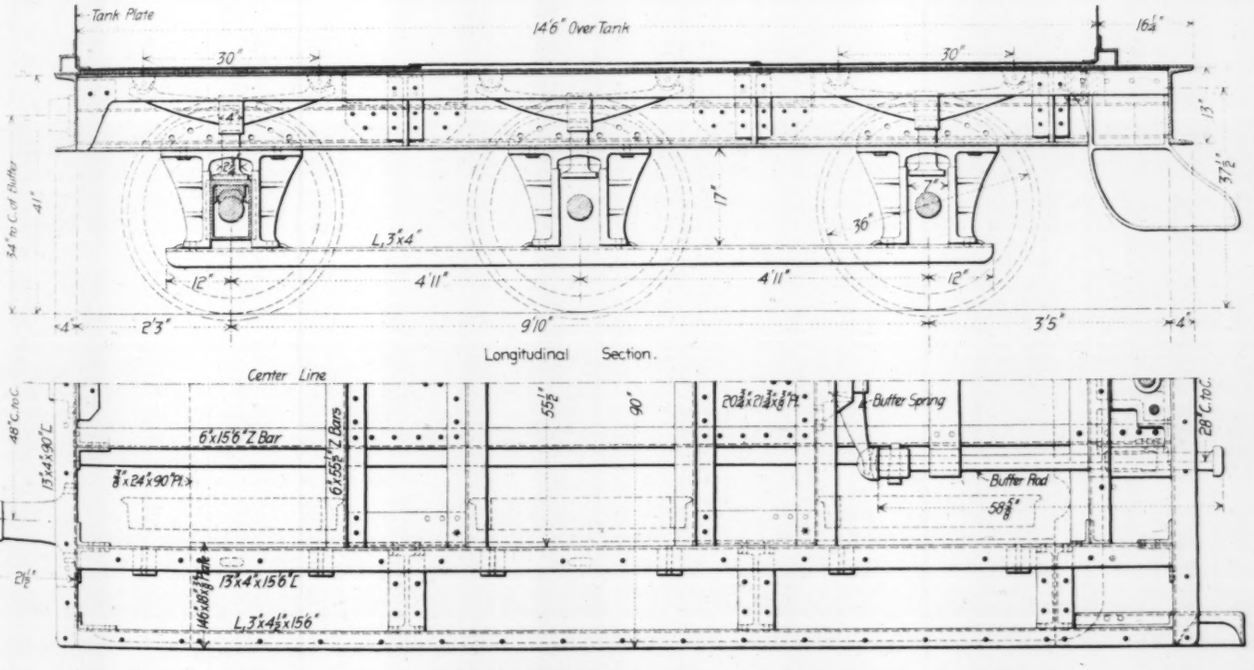


FIG. 1. LONGITUDINAL SECTION AND HALF PLAN OF FRAME.

SIX-WHEEL TENDER FOR THE IMPERIAL GOVERNMENT RAILWAYS OF JAPAN.

Brooks Locomotive Works, Builders.

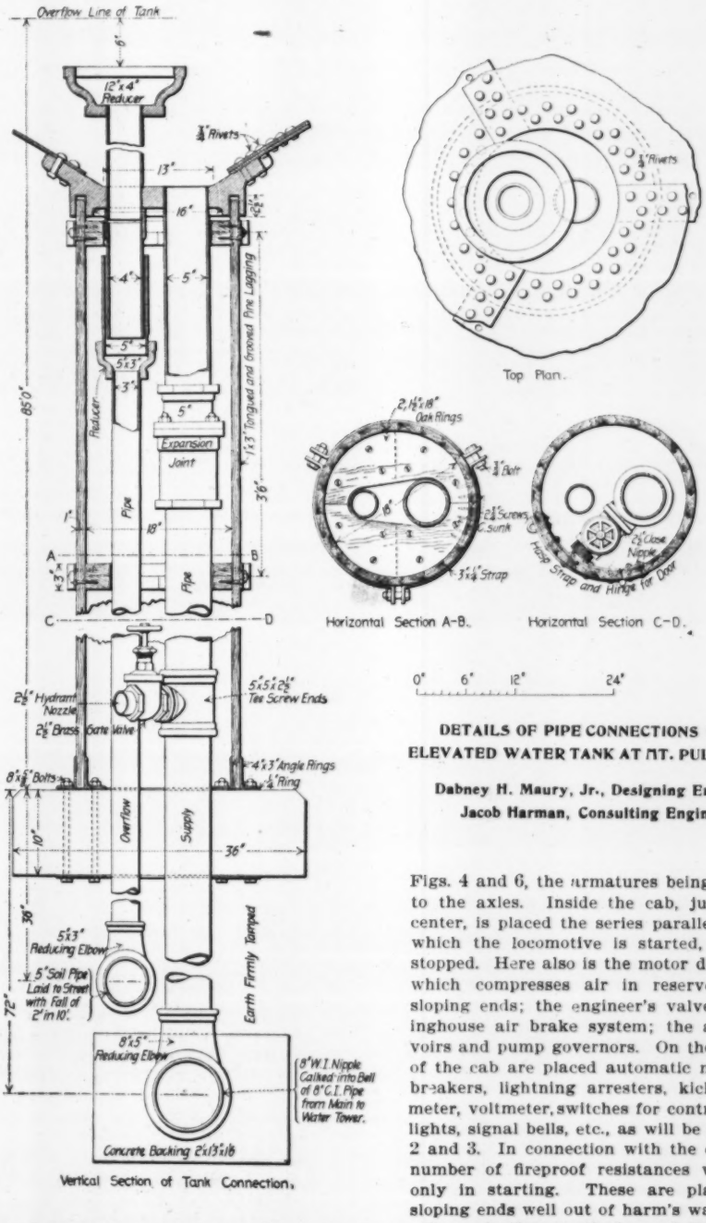
CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

upon this foundation. The floor is of vitrified shale tiles, 10 × 11 × 2 ins., laid in a composition of 70% asphalt and 30% tar. The bottoms of the columns are encased in lead. The columns were carefully cleaned, given a coat of galvanic varnish and then covered with wire lathing upon which was laid an alkaline cement plaster, which was finally coated with an anti-acid paint. The walls and ceilings were coated with the same plaster so as to make them impervious to the acid fumes arising from the cells. To remove those fumes, a ventilating duct provided with openings fitted with valves or dampers is led along the top of each side of the room. Through one of these ducts fresh air is blown into the room, while the air is exhausted through the other and discharged above the roof.

The battery was built by the Electric Storage Battery Co., of Philadelphia, Pa. For information and photographs made use of in this article we are indebted to Mr. Samuel W. Insull, President and Mr. L. N. Ferguson, General Superintendent of the Chicago Edison Co.

SUPPLY AND OVERFLOW PIPES OF ELEVATED WATER TANK AT MT. PULASKI, ILL.

Improvements to the water-works of Mt. Pulaski, Ill., including a new water tank, were made in 1895. Mr. Dabney H. Maury, Jr., was designing engineer, and Mr. Jacob Harman, consulting engineer for the work, both residing at Peoria, Ill. The tank is of steel, 20 × 25 ft., not including a conical-shaped bottom, and is supported on a 60-ft. steel tower composed of six Larimer columns. The conical bottom of the tank terminates in a special casting, to which the supply pipe is connected, and through which the overflow passes, as shown by the accompanying illustration. The illustration also shows the wooden casing used to enclose the supply and overflow pipes to protect them against the frost. The dimensions and details of these features of the tank are fully shown by the illustration.



DETAILS OF PIPE CONNECTIONS WITH ELEVATED WATER TANK AT MT. PULASKI, ILL.

Dabney H. Maury, Jr., Designing Engineer.
Jacob Harman, Consulting Engineer.

ELECTRIC LOCOMOTIVE FOR THE LONDON CENTRAL UNDERGROUND RAILWAY.

(With full-page plate.)

In our issue of July 1, 1897, a brief account of the plans of the London Central Underground Railway was given, which included such general features as were then determined upon. Since that time the work of tunnel construction has been rapidly progressing, and the General Electric Co., which was fortunate enough to secure the contracts for the entire electrical equipment, expects to have the operating apparatus ready as soon as work is far enough advanced to permit its installation. The usual amount of revision of designs has been necessary to meet the peculiar conditions, and in this issue we are enabled, through the courtesy of Mr. W. B. Potter, chief engineer of the railway department of the General Electric Co., to present the revised plans of the electric locomotives which will be employed to haul the trains on this interesting railway.

As will be remembered, the tunnels, two in number, extend for about 6½ miles under the busiest portion of the City of London at a depth varying from 30 to 80 ft. Suitable stations, 14 in all, will be constructed which will require that the trains be accelerated rapidly and maintain a fairly high speed between stations. To reduce the cost of construction the tunnel was limited to 11½ ft. diameter inside the lining, which at once precluded the possibility of distributing motors throughout the trains, owing to the lack of space between the car floor and the track, and made it necessary to adopt some form of electric locomotive.

The proper design of these required a most careful study of the many conditions governing traffic in the sections likely to use the road, and the consideration of the possible load and many other factors. In the first place, the average speed from terminal to terminal was assumed as 14 miles per hour, and, allowing stops of 20 seconds at each of the intermediate stations, the maximum speed called for was close to 30 miles per hour. It was considered advisable to run trains of 7 cars at 2-minute intervals, and this, with the number of stations and the speed selected, determined the number of locomotives required as 32.

Each train, as planned, would weigh 235,200 lbs. (105 tons), including 336 passengers. With this and the foregoing data charts were prepared giving the power required to move the trains as desired, which varied between 150 and 200 HP. during the time power would be actually applied. In determining this account was taken of air resistance, friction, and the assistance of gravity obtained by constructing the tracks on a down grade on the departing side of each station.

In general appearance the locomotives resemble those used on the Baltimore & Ohio Ry. at Baltimore, Md. (Eng. News, July 11, 1895), with the exception that the cab is lower with a roof curved to fit the round tunnel. They are 30 ft. over all by 7 ft. 8 ins. wide and 9 ft. 4½ ins. high. The cab, placed in the center, Fig. 1, is nearly square, being 8¾ ft. × 7⅞ ft. inside and 7 ft. high at the center. The ends are provided with windows, Fig. 3, while the sides are partially open, as may be seen in Fig. 1. The sloping ends are made like the cabin, of ⅛-in. sheet iron, and cover the framing, trucks, etc., at the same time protecting the air tanks and resistances and adding to the appearance of the engine. The body thus formed rests upon two four-wheel trucks pivoted as in American locomotive practice.

These trucks are 10 ft. 1 in. by 6 ft. 1 in. over all, built with forged steel side frames and box girder cross frames, with suitable steel gusset plates and angle bar bracing. The wheel base is 5 ft. 8 ins., the gage 4 ft. 8½ ins., and the distance between truck centers 14 ft. 8 ins. The wheels have 42-in. steel tires forced on cast-steel centers with 12 spokes. The plows which run on the third rail and collect the current, are placed under the center of the trucks. They are simply flat cast-iron plates suspended by cast-iron links exactly as on the New York, New Haven & Hartford Ry. The motors, four in number, two to each truck, are rigidly mounted upon the truck frame, Figs. 4 and 6, the armatures being keyed directly to the axles. Inside the cab, just about in its center, is placed the series parallel controller, by which the locomotive is started, controlled and stopped. Here also is the motor driven air pump, which compresses air in reservoirs under the sloping ends; the engineer's valve, of the Westinghouse air brake system; the auxiliary reservoirs and pump governors. On the sides and roof of the cab are placed automatic magnetic circuit breakers, lightning arresters, kicking coils, ammeter, voltmeter, switches for controlling the train lights, signal bells, etc., as will be seen in Figs. 1, 2 and 3. In connection with the controller are a number of fireproof resistances which are used only in starting. These are placed under the sloping ends well out of harm's way.

Some further particulars of these locomotives are: Total weight of engine, 42 tons; starting draw-bar pull, 14,000 lbs.; draw-bar pull at a speed of 22 miles per hour, 8,000 lbs. Total weight of motor, 12,000 lbs., of which the motor frame and field coils weigh 6,500 lbs., and the complete armature 2,500 lbs. In designing the motor it was specified that the maximum current density in the motors should not exceed 1,500 amperes at speeds above 15 miles per hour, and that at 27 miles per hour on 500 volts the current per motor should not exceed 123 amperes. The efficiency of the locomotive, it is expected, will be about 92% with a temperature rise of 90° F in two hours at full load.

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Assistant Naval Constructor Richmond P. Hobson is set down in the official list of the Navy as a non-combatant; but his engineering skill and ability and his coolness in the face of serious danger have won for him fame that any member of the "fighting line" of the Navy may well envy. The line officer would doubtless have shown equal courage under similar conditions; but the workmanlike manner in which the entrance to Santiago harbor was blocked, the care taken in getting the "Merrimac" into exactly the proper position before sinking her, and the cool attention paid to every preliminary detail, in order to ensure final and complete success, were directly due to his engineering training and to a full understanding of the purpose for which he was risking his life and that of his men. While he is a naval officer, he is also an engineer, and a member of the American Society of Naval Architects and Marine Engineers; and his gallant deed reflects honor upon the profession to which he belongs, as well as upon the Navy in which he holds his commission.

The use of coke breeze as a filtering material in sewage purification was the subject of a recent paper before the Western Society of Civil Engineers by Mr. John W. Alvord, M. Am. Soc. C. E., of Chicago. Mr. Alvord has also recommended, as briefly noted in our issue of June 2, the use of this material at Columbus, O., in a report made jointly by him and Mr. Julian Griggs, City Engineer of Columbus. The principal advantage claimed by Mr. Alvord for coke breeze is its coarseness of grain and the amount of available oxygen stored in the pores of the coke. What the latter claim really amounts to is not shown in the paper. The main point insisted on is that a more complete air supply can be furnished to the whole bed with large than with small grains, an end which the author makes no pretence of not being possible of fulfilment as effectively with other materials as with coke, except for the amount of air taken up by the coke itself.

Where plenty of good sand is available and land is cheap no improved substitute for intermittent sand filtration has yet been found. The various other methods of filtration proposed aim chiefly to reduce the filtration area or minimize the sludge disposal problem, but choice between these methods and intermittent filtration, in the present stage of development, depends almost wholly on such local conditions as prices of land, sand, gravel or coke and labor, the necessity of pumping possibly adding new factors, when it exists.

In England, the term biological or bacterial filters has been applied to real or alleged new processes of filtration. All these processes are but variations of intermittent filtration, as practised for years.

At Columbus it is proposed to employ double filtration through coke breeze, using two areas of 18 acres each for an ordinary sewage flow of 15,000,000 gallons and a maximum of 20,000,000 gallons per day. This will be at the approximate average rate of 500,000 gallons an acre for the whole area in use. Judging from such information as has been made available by recent experiments the degree of purification likely to be obtained by this plan will range somewhere between that given by chemical precipitation and intermittent filtration. A more definite prediction, in view of the uncertainties of the case and the claims of the advocates of this system, we will not venture to make. We think the engineers have shown wisdom in advising the construction of only two beds of one acre each for the purpose of a preliminary test for one season before proceeding further. The plans recommended must be approved by the Ohio State Board of Health before the work can be carried out.

The long voyage of the Unites States battleship "Oregon," lasting from March 14 to May 24, and extending from San Francisco south around the continent of South America and thence north to the coast of Florida, ranks as one of the most remarkable continuous voyages ever made by a naval vessel. The total distance covered was nearly 14,000 miles, which was made in 71 days; but a number of days were consumed in stopping for coal at various points and in running at slow speed to keep with the gunboat "Marietta," which accompanied the "Oregon" from the Straits of Magellan to Rio Janeiro. From Barbadoes northward a wide detour was made instead of taking a direct course through the West Indies. The "Oregon" has a displacement of 10,288 tons, engines of 11,111 HP., and her speed on her trial trip was 16.79 knots. The vessel was in perfect condition at the outset of her long voyage, having left the Puget Sound dry-dock on March 6. After more than two months of almost continual steaming, much of the time with engines and boilers pushed to their full capacity, it might have been expected that the vessel would need to be sent to a navy yard for general overhauling and repairs to her machinery; but nothing of the sort was necessary, and she immediately reported for active duty at Key West. Another fact worthy of especial note is the remarkable speed that was made in the run of 3,000 miles from a point off the coast of Brazil, in about 16° south latitude, to Barbadoes, about 13° north latitude. Near Bahia the vessel made a 24-hour record of 375 miles, or an average of 15.62 miles per hour; and the entire run from Bahia to Barbadoes, 2,578 miles, was made in nine days, or an average of 286 miles per day. When it is considered that this phenomenal speed was made after a voyage of nearly 10,000 miles, with its resulting exhaustion of the engine and fireroom forces and with the fouling of the vessel by tropic seas, and further that this speed was made when crossing the equator, where the heat to which the forces below decks were subjected was at its greatest, the remarkable character of the performance becomes apparent. The feat which the "Oregon" has accomplished reflects great credit on her gallant commander, Capt. C. E. Clark; her chief engineer, Robert W. Milligan; her builders, the Union Iron Works of San Francisco, and, last but by no means least, on the navy of the nation whose flag she carries.

It cannot fail to impress any close observer of public affairs that the most important result of the present war to the United States appears likely to be its influence upon popular opinion as respects many matters of our national policy, and the change in that policy in many respects which now seems likely to be brought about. Some of these profound changes we may discuss at some future time; at present we merely desire to note that the war is likely to bring about the construction by the United States Government of the Nicaragua Canal. Perhaps it would have been built any way. As to that no one knows, nor ever can know; but it is at least certain that the American people now appreciate the military argument for the construction of the Nicaragua Canal as they never have in the past. Further than this, it is by no means unlikely that the need of the canal by the nation from a purely military point of view may be much greater in the future than in the past. Our Pacific coast, with its few harbors, is capable of almost perfect defence by a system of fortifications already planned and well advanced toward completion, in co-operation with a few good war vessels. But if the Sandwich Islands are to be United States territory, if the Philippines are to be governed and protected from Washington, and, last but by no means least, if we are to take the stand that our great and growing commerce with China is not to be cut off at the pleasure of the Russian and German and French in the process of slicing up that territory in which they are now engaged—if these tasks are to be ours, then the value to us of a Nicaragua Canal from the military point of view alone is increased tenfold. It is altogether probable that public sentiment has condemned in the past and still condemns the proposal that the Government should guarantee the bonds of the old Nicaragua Canal Company. It is equally probable that the proposition that the Government itself should undertake the work of building the canal with its own money and for its own benefit would meet with general popular approval. The Government even now, as our readers will recall, has surveys in progress there. The commission in charge of these surveys has asked for additional funds to continue the work, and Congress will make a great mistake if it does not respond to this call before its adjournment. These surveys ought to be continued on the most liberal scale, so that at the earliest possible date we may have authoritative facts and figures as to the magnitude of the task which lies before us in Central America.

The diplomatic difficulties which have heretofore promised to be rather troublesome in connection with a Nicaragua canal have also been greatly smoothed by the events of the past few months. With the present feeling between this country and Great Britain it should be possible to bring about an amicable agreement respecting the much-discussed Clayton-Bulwer treaty. Great Britain, we believe, would willingly grant this country every privilege it needs to make the canal of greatest use for the nation's defence, while at the same time England, which has of late proved herself so truly a friend in time of need, would be assured of equal privileges in the commercial and military use of the canal with ourselves.

In this connection, however, it is worth while to note that if the military uses of the canal are to be a prominent reason for its construction, we shall do well to see that the plan adopted for the canal shall take into due consideration the possible chances of its malicious injury in time of war. The plan of the Nicaragua Canal Company, as our readers will remember, provided for the flooding of the San Francisco basin by a series of earth dams from 5 to 60 ft. in height, built in a country a large part of which is an impassable morass and subjected to a rainfall of 200 to 300 ins. per annum. These dams are scattered along a distance of some 15 miles, and their total extent is from 6 to 7 miles. The opportunity which this great extent of embankment in a tropical forest would offer to the emissary of an enemy bent on putting the canal out of use will be easily appreciated. A single charge of dynamite at any one of these embankments would let out a flood which no power on earth could stop, and might perhaps leave a fleet of battleships in transit through the canal stranded in the mud. Such a break might do damage that months could not repair. Until it is conclusively shown that the "high-level" line of Mr. Menocal is the only one feasible for a

Nicaragua canal, the nation should be very careful about undertaking a work avowedly for national defence but planned on lines that make it so easy of destruction.

LOCOMOTIVE TENDERS AND TRUCK WHEELS.

The difference between American and British practice in respect to locomotive design and construction are always more or less a source of discussion, and two subjects in this relation have, as we happen to know, recently been under discussion among superintendents of motive power in this country. These subjects are as follows: First, tender design; second, the sizes of engine truck and tender wheels. In view of the gradual dissolution of the hard and fast lines which formerly separated the principles of design in each country, we have thought these matters of sufficient interest and importance to warrant us in making some inquiry among motive power men and locomotive builders, in order to get at some expression of fact and opinion upon which to base a general discussion of the subjects.

Taking up first the subject of tenders, it may be said that until very recent years each country has had its own peculiar type, which it has used exclusively. On American railways, the tenders have been of large size and mounted on two four-wheel trucks. In England the size has been somewhat smaller, and three rigid axles have been used, mounted in the main frames of the tender, a certain amount of flexibility being provided by giving the axles a little end play in the boxes. As long as each country used its own type exclusively, as was the case for many years, any discussion on the relative merits might have been promptly settled by the following propositions: First, the English tenders weigh the less and carry less coal and water, so that three axles can safely carry the load, while the average larger radius of curves makes the rigid wheelbase quite practicable. Second, the American tenders are of larger capacity, weigh more, and usually run on lighter track, so that it is desirable to use four axles to distribute the weight, while the proportion of sharp curves renders the use of swiveling trucks indispensable. The latter claim might, perhaps, have been weakened if the extensive use of six-wheel trucks under passenger cars had been suggested, but still the general propositions thus outlined might have been accepted as fairly conclusive.

Within the past few years, however, these two sharp distinctions, like many others in locomotive and car practice, have shown signs of fading away, so that the above propositions can no longer be accepted as conclusive. A few railways in this country (four at least that we know of) are now using six-wheel tenders, and at least two railways in Great Britain (both in Scotland) are using eight-wheel tenders. So far as we know, all the six-wheel tenders on American lines are of the English type, but while one of the Scotch railways has followed American practice in using two four-wheel trucks, the other is using one truck (under the forward end) and two rigid axles.

In the preliminary consideration of this subject we obtained particulars of a large number of tenders and tabulated them for comparison. This information is not of sufficient importance to warrant its being given in full, especially as the relations of weight and dimensions vary within such wide limits on individual roads, but the summary given in Table No. 1 may be useful as showing clearly the practice in both countries, the six-wheel American tenders and eight-wheel British tenders being as yet somewhat exceptional.

In comparing these figures, we see that American tenders weighing 70,000 to 92,000 lbs. carry from 13,440 to 20,000 lbs. of coal and 3,000 to 5,000 gallons of water, while English engines weighing 58,000 to 100,000 lbs. carry only 6,720 to 11,200 lbs. of coal and 2,500 to 4,100 gallons of water, the latter being exceptional. It will also be seen that some of the heaviest tenders are carried on six wheels. In regard to coal capacity, the maximum is probably reached in some eight-wheel tenders of the Union Pacific Ry., and Cleveland, Cincinnati, Chicago & St. Louis Ry., which carry 12 tons of coal. A comparison of the wheelbase, also, shows that the American six-wheel tenders have a much shorter wheelbase than similar British tenders of equal weight, namely, 11½ ft. as against 13 ft. In regard to the British eight-wheel tenders, it will be noted with some surprise that a tender with the enormous weight of 100,000 lbs. carries only about 10,000 lbs. of coal. In regard to the great differences in tank capacity of tenders of approximately the same size, it may be explained that this is due mainly to variations in the shape and size of the tanks. The dimensions given are those of the side of the tender (the height being exclusive of the collar, which adds 12 or 14 ins. depth to the coal space). With the ordinary horseshoe tank, however, the legs do not always extend the full height or length of the side, while the transverse end varies very considerably in shape and size. It is to be noted, also, that in some English tenders, the tank has a well extending down between the frames, an arrangement which is not practicable with the ordinary flat floor framing employed on American tenders. In the table, the capacities of the English tenders have been converted into U. S. gallons.

The experience with six-wheel tenders in this country, though limited in extent, has been in general satisfactory, and we are inclined to agree with views expressed by Mr. G. W. Rhodes, of the Chicago, Burlington & Quincy R. R., to the effect that this type of tender has many advantages, and may in many cases be introduced with beneficial results. The elimination of the truck frames and bolsters, one axle, and a pair of wheels, will reduce the dead weight, and with rigid axles a larger diameter of wheels may be employed, thus reducing the journal friction and the tendency to hot boxes. In contradistinction to this, however, is some evidence from foreign railways using the American type of tender. Of the great number of locomotives built for Russian railways by the Baldwin Locomotive Works, some have been fitted with eight-wheel and others with six-wheel tenders, and it is stated that the former appear to receive great favor with Russian engineers, although their own practice heretofore has been confined to the six-wheel type. Furthermore, we learn from an American engineer who was recently in Buenos Ayres that he examined some locomotives which had just been received from a well-known English locomotive works, and remarked to the Locomotive Superintendent upon the excellent design and workmanship of the six-wheel tender, stating that there was some disposition on the part of American railways to adopt it. The Locomotive Superintendent, however, replied that Americans would not do well to make such a change, inasmuch as the experience on the Argentine railways was strongly in favor of the American eight-wheel tender, as being more flexible and easier upon the track. There is said to be but little difference in cost between a six-wheel tender with plate frames, and an American eight-wheel tender having the same quality of materials and workmanship, and if as much care is expended in securing the best design and the best workmanship upon an eight-wheel tender it is doubted by some whether there will be any difference in the expense of maintenance in favor of the six-wheel tender.

Whatever may be the relative quality of construction of the tenders of both types on the Delaware, Susquehanna & Schuylkill Ry., its experience in regard to maintenance has been decidedly in favor of the six-wheel type. Mr. J. R. Wagner, Superintendent of Motive Power and Machinery, informs us that these tenders require no repairs beyond the renewal of worn brakeshoes, while the eight-wheel tenders require frequent repairs to various parts. Mr. Wagner notes, however, an important point in regard to the design of the six-wheel tenders, and that is the necessity of bracing the deep plate frames to prevent buckling. He has found it necessary to put on an extra crosspiece between the lower portions of the frame for this purpose, and points out that such cross bracing should be provided in the original construction.

The questions relative to the difference in the size of wheels on American and English tenders are discussed further on.

One of the principal objections urged against the English type of tenders is that a six-wheel, rigid wheelbase tender cannot be successfully operated on lines having sharp curves. It may be pointed out, however, that some of the American tenders of this type have a wheelbase materially shorter than that of the English tenders, namely 11 ft. 6 ins., as compared with 13 ft. As thousands of the latter are in daily use, and pass easily around turnout curves as well as main line curves, it does not seem as though any injurious wear of the track or the wheel flanges would result from the use of six-wheel tenders on any ordinary lines in this country. Mr. G. W. Rhodes, of the Chicago, Burlington & Quincy R. R., states that he has six-wheel tenders on one express engine and five suburban engines. On the comparatively straight line between Chicago and Galesburg, 163 miles, an express engine, of the Columbia type with a six-wheel tender (Eng. News, Dec. 5, 1895), has been running for over three years, with "the greatest success." This remark might imply some doubt as to the efficiency of such tenders on a line having numerous curves, but it may be noted that they are used on the Delaware, Susquehanna & Schuylkill R. R. and the Erie & Wyoming Valley R. R., in Pennsylvania, and as coal roads in Pennsylvania are not apt to be specially free from curves it may reasonably be assumed that these tenders are found satisfactory for service on lines with at least a fair proportion of somewhat sharp curves. We have already referred to their successful use on the former line, and Mr. George B. Smith, President and Superintendent of the Erie & Wyoming Valley R. R., states that the six-wheel tenders have given first-class satisfaction. It may be pointed out, also, that sleeping-cars with six-wheel trucks are run regularly on lines having numerous and sharp curves. The standard wheelbase of such trucks is 10 ft. 6 ins., though some trucks have a wheelbase of 10 ft. 10 ins. It is true that this is somewhat shorter than the shortest tender wheelbase, and no doubt the fact that the trucks are attached to the ends of a long arm (the car body) serves to guide and ease

TABLE No. 1.—Tenders of American and English Locomotives.

Railways.	Wheels—No.	Wheels—Diam., ins.	Wheel-base, ft.	Wheel-base, ins.	Weight, loaded, lbs.	Coal, lbs.	Water, gals.	Length over frames, ft.	Length over frames, ins.	Tank—Length, ft.	Tank—Length, ins.	Tank—Width, ft.	Tank—Width, ins.	Height, ft.	Height, ins.
American Railways.															
Chic., Burl & Quincy ...	6	42	11	6	90,000	18,000	5,000	22	5	20	11	9	6	4	0
	8	36	15	8	74,000	17,500	5,000	21	4	19	0	9	6	4	10
Erie & Wyoming Valley.	6	42	11	6	90,000	15,000	4,000	22	7	20	6	9	0	3	10½
	8	30	14	7	67,000	15,000	2,800	21	0	19	4	8	6	3	6
Del., Susq. & Schuylkill.	6	42	11	6	82,000	16,000	4,000	22	7	20	6	9	0	3	10½
	8	33	15	0	68,000	14,000	3,000	21	0	19	4	8	6	3	9½
Pennsylvania*	6	45	..	..	57,850	9,000	2,221	..	..	..	..	..	..	..	..
New York Central†	8	40	15	2½	80,000	13,500	3,587	19	3¼	18	8	8	8	4	0
	8	36	15	10½	97,600	17,000	4,500	..	..	..	..	..	..	..	..
Chicago & North Western	8	36	15	10	92,400	16,000	4,350	20	3½	19	0	9	2	4	8
Erie	8	36	16	1	80,878	20,160	3,600	..	..	18	8⅜	..	..	4	8
At., Top. & San Fe.....	8	33	16	6	92,400	16,000	4,650	..	..	19	6	9	1	4	8
British Railways.															
Grt. North'n of Scotland	6	49	13	0	78,400	.....	3,600	..	..	..	..	..	..	..	..
	8	45½	16	6‡	80,640	6,720	3,600	..	..	..	..	..	..	..	..
Caledonian	6	48	13	0	87,500	.....	3,420	21	6	18	0	7	2½	3	5½
	8	..	..	..	100,800	10,080	4,950	..	..	..	..	..	..	..	..
Man., S. & Liv.....	6	51	13	0	93,632	11,200	4,800	..	..	..	..	..	..	..	..
Great Northern	6	49½	13	0	74,788	11,200	3,480	20	3½	19	5	6	8	4	2
South Eastern	6	48	12	0	68,320	8,960	3,180	20	0	18	0	5	8	4	2
Great Western	6	48	15	0	72,800	.....	4,320	..	..	..	..	..	..	..	..
Highland	6	45½	13	0	80,640	11,200	2,700	21	0	18	6	7	3	3	5
Lan. & Yorkshire	6	43⅜	10	6	58,466	6,720	2,160	17	10	16	4	6	9	3	4

*Tender of English locomotive purchased from the London & Northwestern Ry.
†Tender of the largest type of locomotives specially designed for the Empire State Express. Those of the other express engines have 36-in. wheels.
‡The wheelbase is approximate. The tender has two fixed axles and a leading truck having a wheelbase of 5 ft. 6 ins.

their motion. Nevertheless it certainly seems that all this evidence points to the adaptability of six-wheel tenders on any ordinary line. Sufficient flexibility for all practical purposes can be given by allowing the end axles a certain amount of end play in the boxes, as is done in English practice.

Practically all the American six-wheel tenders are of the English pattern, having two deep plate frames extending the full depth of the pedestals, and slotted for the axle boxes, while portions of the web are cut away between the pedestals so as to reduce the weight. This style of construction, as used on the Chicago, Burlington & Quincy R. R., was illustrated in our issue of Dec. 5, 1895. In this connection it may be noted that some of the locomotives built in this country for foreign railways have tenders of the American type, and others have those of the English type, while still others have tenders with the American style of steel frame, but with three rigid axles whose boxes are carried in pedestals bolted to the steel channels which form the sills. The latter construction, employed on some American engines for the Imperial Government Railways of Japan, is illustrated in another column. This built-up frame is probably easier to make than the solid plate frame, the manufacture of the latter requiring special machinery, but the latter would seem to be the better and more economical of the two.

The next point for discussion is the question of the relative sizes of engine truck and tender wheels on American and English locomotives. As a general thing, these wheels on English railways are of greater diameter than those on American railways, as shown in the table herewith, but it is doubted by some whether this has really any important significance in regard to the performance of the engines. On general principles it is desirable to use the largest diameter of wheel that is practicable, on account of the lower rotative speed, resulting in reduced friction upon the journals, thus reducing the tendency to hot boxes. It is true that our express engines with 33-in. and 36-in. truck wheels run regularly for long distances at high speeds, and give little trouble, but nevertheless detentions due to hot boxes on the engine or tender trucks are not uncommon, and the tendency to this trouble may be lessened somewhat by increasing the size of the wheels. It is, therefore, worth while to consider if this can be done without interfering with other details of construction. On the other hand, it is claimed that the smaller wheels have one important advantage, and that is in having less flange wear than the larger wheels.

The use of bar frames and tender trucks on American engines renders it necessary to use wheels of smaller diameter than on English engines having plate frames and rigid tender axles. The use of outside cylinders also has an influence in this direction, except on engines with large driving wheels, and most English outside cylinder engines have such wheels. There are, however, some English engines of this type with driving wheels only 63½ and 68½ ins. diameter, whose truck wheels are 38½ ins. diameter. Another reason suggested for the general use of small wheels in this country, is that while English railways have universally used steel-tired wheels, American engines have usually been fitted with cast-iron wheels, and it is not easy to make good chilled cast-iron wheels of greater diameter than 33 ins. This diameter was for many years practically a standard, both for cast-iron and steel-tired wheels, for though some foundries attempted to cast 42-in. wheels, the results were not satisfactory, and the wheels were never very generally introduced. The Pullman Palace Car Co. for several years used a 42-in. steel-tired wheel, but some years ago it adopted the 38-in. wheel, which is now its standard. Mr. Geo. F. Brown, General Manager of the company, informs us that the principal reason for the change was that with the 42-in. wheel it was necessary to cut away the floor of the car, which objection was overcome by the use of the 38-in. wheel. We are further informed, however, that greater flange wear and the small space available for getting at the brake rigging were among the objections to the larger wheels.

A more important reason for this difference between English and American practice, and the one which is in all probability the fundamental or governing reason, is the difference in the height of drawbars. In this country the standard height to center of drawbar is 34½ ins., with a maximum of 37½ ins., and a minimum of 31½ ins. In England, however, the usual height is 40 ins., and on some engines even 42 ins., so that the frames are set about 6 ins. higher than in this country.

In Table No. 2 are given the sizes of driving and truck wheels on American and English locomotives of approximately similar type and size, this table having been condensed from an extensive list prepared as a basis for the present discussion:

TABLE No. 2.—Relative Diameters of Driving and Truck Wheels.

	American.			British.		
		Wheels—			Wheels—	
Type of engine.	Railway.	Driving, ins.	Tr'k or leadg., ins.	Railway.	Driving, ins.	Tr'k or leadg., ins.
8-wheel...	N. Y. Cent..	86	40	No. East[1]..	91¼	4.5¾
"	Penn.	80	36	Lan& Yrk[1].	87&72	36½
"	N. Y. Cent..	78	36	Gt. West[1]..	84	48
"	NY,N.H.&H.	78	33	L., C. & D[1].	78	42
"	C. & N. W..	75	36	Highland...	75	39
"	Wabash	69	30	Gt.N.of S.[1].	72½	45½
"	N.Y.O & W.	68	33	Lon. &S.W.	70	40
"	St. L. & Ad.	64	28	No. Lon.[2]..	65	3.5½
10-wheel...	A.,T. & S.F.	73	30	.....	..	..
"	Erie	62	30	Highland...	63½	38½
Columbia.	C.,B. & Q..	84¼	50¼	Lon.&N.W.	85	49½
"	Phil. & Rdg.	78	48	.....	..	..
Atlantic..	Lehigh Val..	78	36&54	Gt. Wes.*[1].	90	48&54
Single....	Phil. & Rdg*	84½	36&54¼	Gt. Nor.*..	97½	47&55½
6-wheel...	Penn.†[1]	74	45	Gt. East.[1]..	84&68	48

[1]Engines having inside cylinders.
[2]Tank.
*These three engines are all similar to the Atlantic type, except that they have only one pair of driving wheels, instead of two. All have 4-wheel leading trucks, and a single pair of trailing wheels.
†This is the English engine purchased from the London & Northwestern Ry. It has four driving wheels and a single pair of leading wheels.

In this country, pony trucks with 50¼-in. wheels are used on some engines of the Columbia type, but the largest wheels used on four-wheel trucks are the 40-in. wheels used on the largest type of eight-wheel engines which haul the Empire State Express on the New York Central R. R. Diameters of 36 and 33 ins., however, are those commonly used, but wheels as small as 30 ins., and even 28 ins. diameter, are to be found on some passenger engines.

The smallest truck wheels we find on English railways are 33½ ins. diameter, and these are on outside-cylinder tank engines of the eight-wheel type in use on a London local line (Eng. News, 1891). Next come 36½-in. wheels on inside-cylinder eight-wheel engines of the Lancashire & Yorkshire Ry., having 72-in. and 87-in. driving wheels. The largest truck wheels we find are 48 ins. diameter, on inside-cylinder eight-wheel engines of the Great Western Ry., though single leading axles with 49½-in. wheels are used on some roads. By far the most common sizes, however, are from 42 to 48 ins. diameter.

In both countries it is noticeable that engines having a single pair of leading wheels or a pair of trailing wheels behind the driving wheels have these wheels considerably larger than the wheels of ordinary four-wheel trucks. Thus in the table it will be seen that engines of the Lehigh Valley R. R. and Philadelphia & Reading R. R. have 36-in. truck wheels, and 54-in. trailing wheels, while similar English engines have 47-in. and 48-in. truck wheels, and 54-in. and 55½-in. trailing wheels.

Coming now to the question of the tender wheels, the greater height of drawbar and the absence of truck frames permit of the use of larger wheels abroad than under the conditions which obtain in this country. Here, 30, 33 and 36 ins. are the usual sizes, while in England the average is 45 ins., sometimes 42 or even 51 ins., as shown in Table No. 1. Six-wheel tenders without trucks are in use to some extent here, as already described, and these have wheels 42 ins. diameter, while some English engines with trucks under the tenders have 45½-in. wheels. With a diamond frame truck it is difficult to use wheels larger than 36 ins. diameter. When Mr. Player was Mechanical Engineer of the West Shore R. R., he equipped all the tenders of passenger engines with 42-in. truck wheels, making necessary a special design of truck (since used by the Chicago, Burlington & Quincy R. R.), in which the height of the center plate was kept down. We are informed, however, that actual service showed that the 42-in. wheel had no advantage over the 33-in. wheels, while they cost more, the new tires for renewal cost more, and heavier and more expensive axles were required in order to stand the increased strains due to flange impact. With the greater height of drawbar and frame of English tenders, however, the larger wheels have an advantage in reducing the length of the pedestals or "horn blocks," as very long pedestals for small wheels on rigid axles under high frames would have to be very heavy to withstand the strains due to flange impact. The big eight-wheel engines of the New York Central R. R., which haul the Empire State Express, have tender and truck wheels 40 ins. diameter. The tender trucks have a special form of diamond frame, with horizontal top bar, and over each frame is an inverted semi-elliptic spring, the ends of which rest in shoes over the boxes, while its middle carries the side-bearing. The tender frame is set high up, and the drift gear is below the sills.

From the information which has been presented it may be said that while there is not sufficient information or experience to warrant the presentation of any definite conclusions, the general evidence does seem to tend towards the following conclusions:

First, the six-wheel tender appears to offer sufficient advantages to make it desirable to give it a more extended trial in this country.

Second, on engines for fast passenger service it is not advisable to use truck wheels less than 33 ins. in diameter, and good results may be expected to follow upon the use of even larger sizes, where this is practicable, as it is in certain types of engines.

LETTERS TO THE EDITOR.

A Theory for Placing Stiffeners in Plate Girders.

Sir: Referring to the communication on "A Theory for Spacing Stiffeners in Plate Girders," in your issue of May 19, I beg to say that your correspondent's conclusions are erroneous. The faulty conception on which his first conclusion is based is clearly shown in Article 130 of Johnson's "Framed Structures."

Again, the analogy between a stiffened plate girder and a Pratt truss exists neither in theory nor in fact, as has been pointed out by Prof. W. H. Burr and Mr. Edwin Thacher, in their discussion of Mr. J. M. Wilson's paper on "Specifications for Strength of Iron Bridges," (Trans. Am. Soc. C. E., Vol. XV., 1885), in which a similar theory was advanced. And finally, even if so faulty a premise be accepted, the proposed formula for spacing remains itself wholly irrational.

While the size of stiffeners is purely a matter of empiricism, and their spacing hardly less so, yet experience has shown that the relations usually observed in current practice are entirely adequate. In the sketch submitted by your correspondent, the spacing of the stiffeners in the end panels is unnecessarily close. In the central panel, either two pairs of stiffeners should have been introduced, or they should have been wholly omitted, this depending, of course, on the value of the shear and on the thickness of the web plate.

Very truly yours,
E. M.

Philadelphia, Pa., May 24, 1898.

The Rigidity of the Niagara Railway Arch Bridge.

Sir: In your issue of May 26 you comment on the extreme rigidity of the arch bridge over Niagara Gorge, and call attention to the inclination of the main trusses as a major factor in securing the vertical as well as the lateral rigidity. That this excellent feature of the design has a marked effect in increasing the lateral rigidity is true, since: (1) It increases the lateral distance between the skewbacks, giving as it were a broader base for the bridge to rest on; (2) It causes the lower ribs to be inclined towards each other in the plane of the intrados whereby they are able to relieve the lower lateral system of no insignificant portion of the shear due to lateral pressure; (3) It enables the main truss itself to act as a lateral truss, its efficiency as such increasing with the cosine of its angle of inclination with the horizontal.

On the other hand, the efficiency of the main truss, and consequently its vertical stiffness, increases for vertical loading as the cosine of its angle of inclination with the vertical increases, becoming a maximum when this cosine is unity or the truss vertical. The line of reasoning offered in support of the opposition view (that the vertical stiffness is increased by the inclination of the trusses) is as amusing to the practical bridge builder as would be the statement that the Forth Bridge deflects less vertically than the Brooklyn suspension under live load since the trusses of the Forth Bridge are inclined towards each other, whereas (forsooth) the stiffening trusses of the suspension bridge are vertical.

Between two beams of equal strength and of different depths one would naturally select the deeper as the more rigid under load, and the correctness of such a selection may be readily demonstrated mathematically or experiment-

ally. So, also, between two arched ribs of equal strength the one possessing the greater depth between flanges or chords would naturally exhibit the greater rigidity under live load. A comparison of the Niagara arch with the arch of the Washington bridge will show such a marked difference in the above respect that a corresponding difference in vertical stiffness should be naturally expected under moving loads.

Yours truly,

C. A. P. Turner.

Minneapolis, Minn., May 31, 1898.

A Simple Positive Blue Print Process.

Sir: We have recently worked out the following simple and practical process for making positive blue prints—that is, prints having blue lines upon a white ground, and

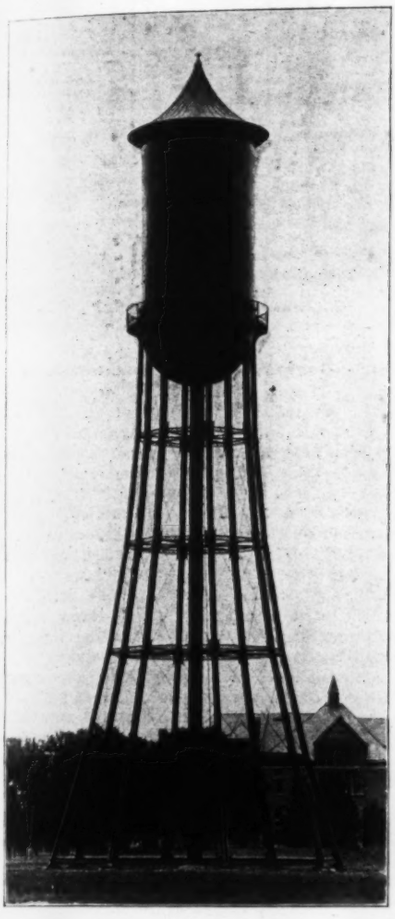


Fig. 1.—View of Elevated Water Tank of the Iowa State Agricultural College.
A. Marston, Assoc. M. Am. Soc. C. E., Engineer.

find it very convenient for the rapid duplication of standard drawings and of maps upon which subsequent plotting or coloring is desired. No special skill is required to work it.

We make our tracings with strong, black lines, using Higgins' "American White Label" india ink. A paper negative is first made on ordinary protographic silver printing out paper, such as Solio, or Kloro paper. We use the "Victor Special" brand, which can be had in rolls 25 ins. by 30 ft,. and is not expensive. To make the negative, cut the paper one-half inch larger each way than the tracing; place the tracing in an ordinary blue-printing frame, face up—that is, with the side drawn upon away from the glass; on this place the paper face down, so that the inked lines and the sensitized surface are in contact; then print in the sun to a dark coffee color. The print is soaked in water until drippings from it are no longer milky. It is then placed in a fixing bath made up about as follows (exactness is not important): Hyposulphite of soda, 1 ounce; water, 25 ounces.

The print will change in this bath to a uniformly light mahogany color or dark buff. After becoming uniform in tint, it is left in the bath five or ten minutes longer. It is then removed and washed for half an hour; then allowed to dry thoroughly, after which it will be much darker. When thoroughly dry the back of the negative should be given three good coats of the following varnish: Canada balsam, 1 part by volume; spirits of turpentine, 3 parts by volume; alcohol, 2 parts by volume. Apply quickly with a sponge. Let each coat dry before applying another. Work in a warm room.

The result is a fairly transparent negative (reading backwards) of a non-actinic color, with clean white lines and figures, from which the positive blue prints are made on ordinary blue-print paper. Printing takes about twice as long as in the case of those ordinarily made, from a tracing, but several negatives can be made from one tracing if many prints are required. When through printing we file the negatives with the tracings, for future use.

The best method of getting the time of exposure for making the negative is to try one or two scraps of the paper first under the tracing and note the time giving the best negative; after which, uniform results can be had without difficulty. At this season of the year (May) the printing requires three and a half minutes in the sun in the middle of the day, under a clean tracing. If here and there a line or figure in the negative is indistinct from bad contact in the printing frame, it may be easily "doctored" by scratching with a pin-point or other sharp point through the gelatine surface of the paper after the negative is otherwise finished. A fresh fixing bath should be used for each batch of negatives made. Before making the positive blue prints, test a small scrap of the blue print paper by washing before exposure to the light. It should wash clean, leaving no bluish cast to the paper. Soaking and washing the paper negatives, as above, may be done in the blue-print washing tray in which blue prints are being washed, as the two processes do not affect each other.

Yours truly.

John D. Isaacs.

Southern Pacific Railway Co., San Francisco, Cal., May 24, 1898.

(A negative and a print sent us prove this process to be thoroughly satisfactory; the resulting blue print is sharp and clear, and well adapted to any further manipulation. The size of the negative sent is 13 × 8 ins., and it should be understood that the process is intended for the duplication of comparatively small standard plans and maps, though this is a question of the size of the camera. —Ed.)

Notes and Queries.

R. P. R. desires to learn the present address of Mr. Gaston Meslier, who is said to hold an official position on some Western railway.

THE ELEVATED WATER TANK OF THE IOWA STATE AGRICULTURAL COLLEGE.

By A. Marston, Assoc. M. Am. Soc. C. E.*

The accompanying view, Fig. 1, shows a water tower recently designed by the writer, and constructed under his supervision, which is, he believes, the largest elevated tank in the West, and whose design includes some novel features.

*Professor of Civil Engineering, Iowa State College, Ames, Iowa.

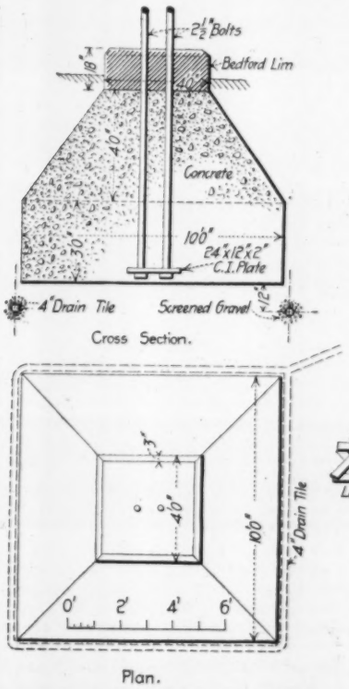


Fig. 2.—Plan and Section of Foundation Pier.

General Dimensions and Features.

The tank is of steel, 24 ft. in diameter by 40 ft. high, besides a hemispherical bottom. The capacity of the tank is about 162,000 gallons. The curved roof and the cornice are of galvanized sheet iron on a steel framework. The tank is supported on a tower composed of eight standard 12-in. steel Z-bar columns, braced together by steel rods and struts. Each lateral strut is composed of four angles laced together. A system of radial struts, each composed of two channels laced together, is also provided at each story. The tower is built in five stories. The column sections are straight between panel points, but these points are placed upon arcs of circles of 320 ft. radius, tangent to the vertical sides of the tank. The lengths of column sections were made the same between panel points for all except the top story, in order to permit as much duplication of parts in the shop work as possible. A balcony is provided at the tops of the columns, its floor being 110 ft. above the cap-stones. The tower is supported on concrete piers, with cap-stones of Bedford limestone. The total height of the structure is 168 ft. above the cap-stones.

The writer designed the tower of so great capacity and height mainly to enable the college to have as nearly as possible the advantages of a gravity system of fire protection. Much of the half million dollars worth of property protected by this tank could not be replaced if destroyed, and during vacations fire-pumps would be very apt not to be ready in case of emergency. Since this system was designed and partly constructed a sister state institution has had a fatal example of the delay liable to occur in getting fire pressure from pumps.

The tower stands in a prominent location on the college campus, and from a distance is the most conspicuous structure in the vicinity. On this account the writer, in preparing the design, kept prominently in mind the appearance of the tower. The only legitimate means for enhancing the architectural appearance of an engineering structure of this kind are to select pleasing proportions and graceful outlines, and to employ only neat, strong-looking details. Any use of sham ornaments is entirely out of place. The same is true of any attempt to disguise the true purpose of the structure by trying to make it look like something it is not. In the present design the general proportions, the curved outlines of the tower proper, the balcony, the hemispherical bottom, the cornice, the curved roof, and the forms chosen

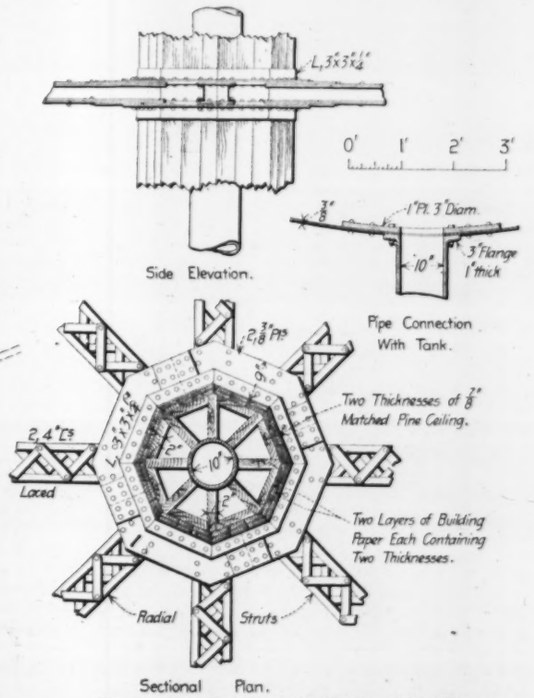


Fig. 3.—Frost Proofing and Stiffening of Inlet Pipe.

for details were features in designing which the writer kept in mind the appearance of the tower. The writer does not know of any other water tower in which the outline of the tower proper is curved, although Mr. Freeman C. Coffin some years ago suggested such a design.

Foundations and Inlet Pipe.

The details of one of the foundation piers are shown by Fig. 2. The soil on which the piers rest is a hard clay, containing some water. It sustains a total load of about 1⅓ tons per sq. ft., besides the pressure of the wind. This, if computed on the basis of 50 lbs. per sq. ft. against a vertical plane surface, will increase the foundation load to about 1¾ tons per sq. ft. The centers of the piers are 31.14 ft. from the center of the structure.

The details of the frost proofing of the inlet pipe are shown by Fig. 3. On account of lack of circulation of the water in winter vacations a heating arrangement was considered necessary to prevent the inlet pipe from freezing up. The details of this are shown by Fig. 4. A 2-in. opening, closed by a valve worked by a wire from the ground, is provided close to the tank for the escape of the heated air. An expansion joint was placed on the inlet pipe just under the tank bottom.

Tower and Roof Details.

The details at the foot of each column are shown by Fig. 5. The load is properly distributed over the masonry plates, and the anchor rod connections do not rely on rivets in tension.

In Fig. 6 the details of column splices, and of radial and lateral connections are shown. It will be seen that the stresses in the rods and struts are transmitted directly to the webs of the posts without causing secondary stresses. The use of square root angles to splice Z-bar columns is due,

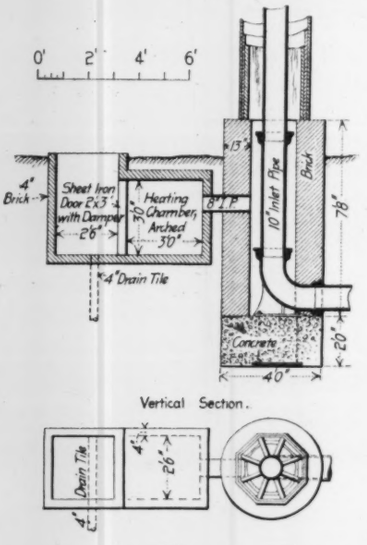


Fig. 4.—Frost Proofing Foundation and Heating Apparatus for Inlet Pipe.

the writer believes, to W. H. Jackson and B. N. Moss, water-works engineers of Des Moines, Ia., and graduates of this college.

The writer used Z-bar columns in preference to latticed channels because they are more accessible for painting, and have no idle material. Eight columns were used in preference to four, in order to bring the task placed upon the metal of the tank shell in transmitting the loads to the posts well within the limits which existing structures have shown to be safe. Also the appearance of the eight-post tower is better. The likelihood of much unequal unloading of the posts occuring is less with the larger number of posts, if they are arranged as in this design, and not as in the old, objectionable twelve-post towers. For small towers material is saved in the four-post tower because the compression members are larger, but in the present design the loads are large enough to require economically-sized sections anyhow.

The details of the radial bracing are shown by Figs. 3 and 6. This bracing serves to stiffen the tower. Theoretically it would not be needed to carry the stresses. The details of the roof and cornice are shown by Fig. 7.

Details at Tops of Columns.

The details at the tops of the columns are shown by Fig. 8. In place of the "drum," or circular plate girder, often put under the vertical sides

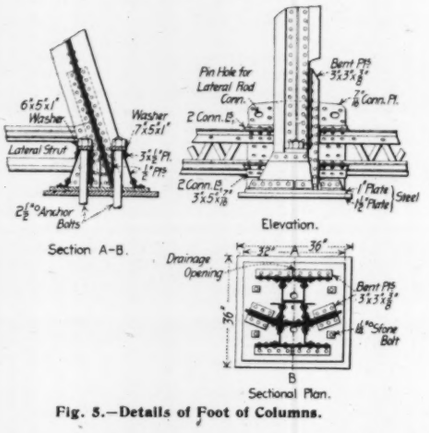


Fig. 5.—Details of Foot of Columns.

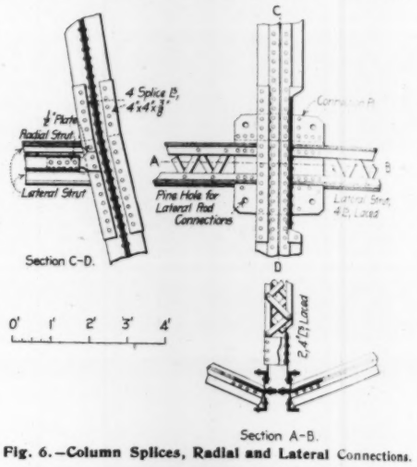


Fig. 6.—Column Splices, Radial and Lateral Connections.

of the tank, the first vertical ring of the tank plates is so strengthened and arranged as to transmit safely the loads to the posts. The omission of the drum renders the whole bottom of the tank readily accessible for painting and driving rivets.

A horizontal circular girder, on which the balcony floor rests, is provided at the top of the posts to resist the horizontal stresses and to hold the tank rigidly to shape.

The details shown in Fig. 8 transmit the loads centrally to the posts. Where the post is carried up along the vertical side of the tank and riveted to it directly, there is difficulty in avoiding eccentricity of loading, which, on account of the magnitude of the loads, may cause very great bending moments in the upper parts of the posts. In one important design recently published the unprovided-for bending moments due to the eccentricity were sufficient, if all resisted by the posts, to cause outer fiber stresses of more than 20,000 lbs. per sq. in.

Hemispherical versus Conical or Flat Bottoms.

The advantages of spherical over flat bottoms for steel or iron elevated tanks, as requiring much less material, and as making it easier to secure and maintain water-tight joints, are now well understood and need not be enlarged upon. The writer desires, however, to express a strong preference for the use of the full hemispherical in preference to either a segmental or a conical bottom, both of which designs complicate the stresses at the top of the columns. The conical bottom also requires more metal than the hemispherical.

No trouble is experienced at the present time in securing favorable bids for the construction of elevated tanks with round bottoms from a number of reliable firms. There is no particular difficulty in the construction or erection of such bottoms.

Specifications and Tests of Material.

The specifications provided that the concrete for the foundations should be composed of one part of Portland cement to three parts of sand and five parts of gravel. "Giant" Portland cement was used. Tests made by the college showed a tensile strength of 403 to 587 lbs. per sq. in. in seven-day tests, and 591 to 646 lbs. per sq. in. in 28-day tests of neat briquettes. When mixed with standard crushed quartz in the proportions 1 to 3 the results were 68 to 111 lbs. per sq. in. in seven-day tests, and 122 to 146 lbs. per sq. in. in 28-day tests. The sand and gravel used were composed of particles of all sizes, from fine to coarse. The gravel was screened twice. Tests showed that it had 30 to 34% of voids. Two tests of 6-in. cubes of the concrete, made from material taken from the piers, after placed there by the workmen, who had no previous warning, showed crushing strengths of 120 and of 152 tons per sq. ft., respectively, at an age a little less than nine months. The cubes had been kept buried 3 ft. deep in the ground near the piers, and were wet when crushed.

The specifications for the steel for the tower and tank provided that neither phosphorus nor sulphur should exceed 0.05%. They also called for material having a tensile strength between 56,000 and 64,000 lbs. per sq. in., an elastic limit not less than half the ultimate strength, an elongation not less than 20% for sheared plates, or 25% for other material, and a reduction of area of not less than 50%. They also called for cold and quench bending tests of the metal flat on itself.

All shop rivets were to be of steel of 52,000 to 58,000 lbs. tensile strength, 26% elongation, and 50% reduction of area. Burden's best iron rivets exclusively were used for field riveting.

All rivet holes in the drum sheet were reamed. Calking edges were beveled. But little trouble was experienced in making the tank water-tight.

All the metal-work received one coat of boiled linseed oil in the shops, and after erection it was given two coats of red lead paint, mixed 30 lbs. to one gallon of raw linseed oil. The final color was a red brown.

The Pittsburg Testing Laboratory were employed by the college as mill and shop inspectors. Their tests of each melt of steel gave results as

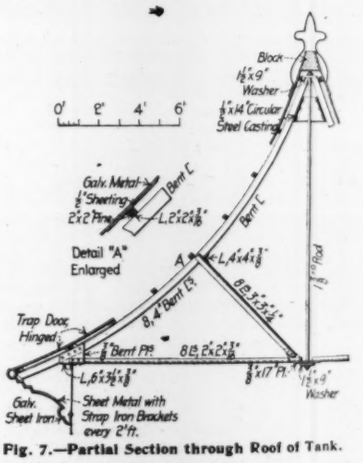


Fig. 7.—Partial Section through Roof of Tank.

follows: Phosphorus, 0.010% to .031%; sulphur, .020 to .033%; elastic limit, 32,910 to 41,480 lbs. per sq. in.; ultimate strength, 55,930 to 64,000 lbs. per sq. in.; elongation, 25 to 34%; reduction of area, 51.8 to 61.4%.

Loads and Calculation of Stresses.

The stresses were computed for the loads due to the weight of the metal and of the water, and

to the wind. The wind pressures assumed were 20 lbs. per sq. ft. for the roof and hemispherical bottom, 25 lbs. per sq. ft. for the tank, and 50 lbs. per sq. ft. for the tower. There is no particular difficulty in getting the stresses due to the weights of metal and water, but in computing the wind stresses the problem is more complicated, because the members meeting at each joint are in different planes. To apply the laws of equilibrium in the regular way is a tedious process. It may be very much simplified by applying the principle that if a section be made just above or below any story, the algebraic sum of the vertical compo-

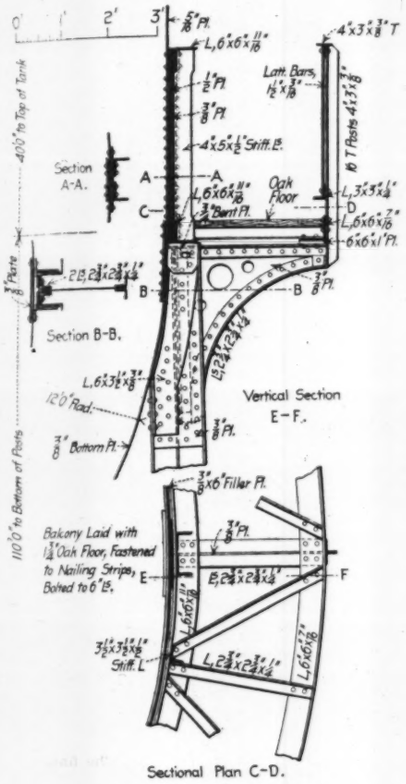


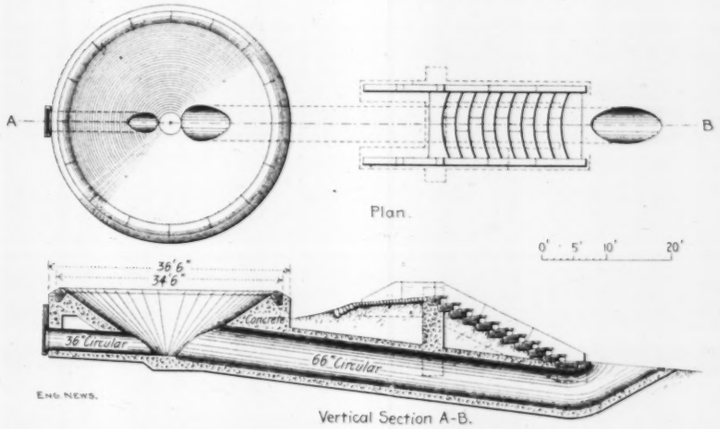
Fig. 8.—Details of Tops of Columns.

nents of the wind stresses cut at any joint is proportional to the distance of the joint from the neutral plane. We can, therefore, compute this sum directly from the wind moment at that section, and by beginning at the leeward or windward post, and using the results from both top and bottom of the same story, we can readily compute all the stresses in the posts and rods. It is then an easy matter by equating the sums of the radial and tangential horizontal components at each joint to zero, to compute the stresses in the lateral struts. As each strut will be computed twice in this process, we obtain at each step an absolute check, both on the theoretical correctness of the principle assumed, and on the numerical accuracy of the work. The writer discovered the principle accidentally, and has not attempted to derive it analytically.

Mr. C. W. McMeekin, Assoc. M. Am. Soc. C. E., has acted as consulting engineer on the tower, as the representative of Mr. Chester B. Davis, M. Am. Soc. C. E. Although the design and its details were both suggested and fully worked up, and construction supervised throughout by the writer, he desires fully to acknowledge Mr. McMeekin's services. Mr. McMeekin suggested the use of bent plates for the lateral rod connections at the balcony, and prepared the specifications. Crellin & Lovell, of Des Moines, Ia., were contractors for the foundations, which cost $1,150.42. The King Bridge Co., of Cleveland, O., were contractors for the rest of the work, for which they received $8,966. The writer desires to mention the care they took in executing the work.

A FUNNEL-SHAPED SPILLWAY FROM A POND AT PROVIDENCE, R. I.

A novel expedient for a spillway is described by the Commissioner of Dams and Reservoirs of Rhode Island, Mr. W. C. Simmons, in his annual report for 1896, which has just reached us. The pond with which the spillway is connected is located in the Roger Williams Park, at Providence, R. I., and its design is credited by Mr. Simmons



A FUNNEL-SHAPED SPILLWAY AT PROVIDENCE, R. I.
J. Herbert Shedd, M. Am. Soc. C. E., City Engineer.

to Mr. J. Herbert Shedd, M. Am. Soc. C. E., of Providence. The dam is of earth, with a concrete heart-wall. For scenic effect a narrow masonry spillway is constructed in the dam in the form of steps, over which the ordinary flow of the stream passes. This spillway is shown in the accompanying illustration. The high water flow of the stream is drawn into a second funnel-shaped spillway of concrete, also shown in the illustration. This spillway has an overflow 100 ft. in length, and terminates below in a circular conduit 5½ ft. in diameter, passing beneath the other spillway, the conduit also serving as a channel to drain the pond when desired.

A RIVETLESS LONGITUDINAL JOINT FOR STEEL PIPE; ADELAIDE WATER-WORKS, SOUTH AUSTRALIA.

By Alex. B. Moncrieff, M. Inst. C. E.*

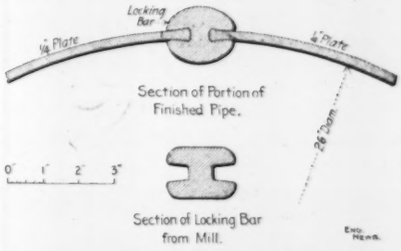
We are now laying in connection with the Adelaide water supply 8¾ miles of steel main, varying from 15 to 26 ins. in diameter, made to a new design. Each pipe is 26 ft. long, and contains four pieces only, viz., two plates and two locking bars. The departmental design was for a riveted main, and tenders were called by public advertisement with the usual provision that manufacture must be in the Province. The new design referred to above was offered as an alternative at a cheaper rate, and, after numerous experiments, was accepted. The contractor erected machinery, the works are now in full operation, and the necessary materials have been imported from England.

Each plate as it is taken from the stack is first passed through a train of leveling rollers, then shorn to the exact length with square ends, at one operation. It is then secured on the bed of a planing machine with sliding table which operates on both sides with four cutting tools. These cut the two longitudinal edges parallel, while eight rollers on each side, carried by the same table and following the cutters, up-set the edges in the form of a dove-tail of uniform depth and width, each plate, 26 ft. long, being planed and dovetailed in four minutes. From the planing machine the plate passes through a hydraulic press, which slightly turns up the edges, then into the rolling mill, which forms each into a semi-circle. Two of these semi-circles are placed in grooves in the locking bars, which are used without further preparation than that given them in the original rolling, the four parts being temporarily clamped together.

*Engineer-in-Chief, Public Works Department, South Australia, Adelaide, South Australia.

The pipe thus formed is next placed on an expanding mandrill in a hydraulic press, and subjected to a pressure, in a length of 5 ins., on both locking bars, of 250 long tons. The inside and outside swages thus applied close the grooves in the bars, and each successive 5 ins. is similarly treated till the closing of the longitudinal joints of the pipe is completed. The finished pipe is then placed in the testing bench and submitted to a test pressure of 260 lbs. per sq. in. The result is a first-class pipe, which in but few instances shows any signs of leakage or even sweating at the joints. Should there be any leakage, no caulking is allowed, but the pipe is returned to the closing machine, which always heals any defect. The usual asphalt coating is then applied, and the jointing of the pipes in the trenches is with steel rings and lead.

These pipes, uncoated, show no signs of leakage at 400 lbs. pressure. We can put in service connections at any place on the locking bar while under pressure. The pipes are of uniform diameter, perfectly smooth inside, and are made as quickly as the riveted mains, of which we have used a considerable mileage.



Rivetless Joint for 26-in. Steel Pipe.
Adelaide Water-Works, South Australia.
Stephan Fergusen, Patentee.

There are, of course, many interesting details in the manufacture, the necessity for which experience only could decide. Further improvements will doubtless be made in the machinery, but the new design of pipe is in every respect a step in advance of the old riveted water mains.

COVERING A STORAGE RESERVOIR AT QUINCY, ILL.

By Dow R. Gwinn.*

The reservoir in question was constructed in 1881-2, and is 415 × 317 ft. at the top, and 26 ft. deep. The excavation made the embankments. The crest of the bank is 15 ft. wide, and the inside and outside slopes are 1½ to 1. The inside slope was puddled to the depth of 9 ins., and a dry limestone wall, 1 ft. deep, laid on the puddle. The bottom, which is sandy clay, was puddled to the depth of 1 ft.; the leakage, if any, is extremely small.

A vegetable growth has given us considerable trouble during the summers, especially since we

*Superintendent Water-Works, Quincy, Ill.

began filtering the water before pumping it into the reservoir. The character of the vegetation was not always the same; one year it was a mossy growth, but the last two summers the growth was about the size of the head of a pin, nearly globular and light green in color. It is generally agreed among water-works experts that algae will not grow in reservoirs that are protected from the direct rays of the sun, and the writer is of the opinion that filtered or artesian water is more favorable to the growth than impure or murky water. In response to inquiries among water-works managers who have charge of covered reservoirs in Colorado and California, the writer was informed that roofs are entirely successful, as the algae does not grow when the water is so protected. The plan of using a floating raft was given considerable attention, and the following conclusions were reached: (1) That the life of white pine under such unfavorable conditions would be short, and that cypress would become water-logged and sink. (2) That without a circulation of air above it, the water would deteriorate. (3) The only experiment ever made with a raft in a reservoir proved in the end to be a failure.

The matter of a roof was then taken up, and the writer is indebted to Mr. Chas. P. Allen, of Denver, for plans of the roofs constructed by him in a number of western cities. The supports in the Quincy reservoir are the same as used by Mr. Allen (6 × 6-in. posts), but the upper framework is on a different plan, as it was desirable to reduce the number of posts to a minimum. Each section of the Denver roof covers 160 sq. ft. of surface (8 × 20 ft.), while a section in ours covers 252 sq. ft. (14 × 18 ft.). Mr. Jos. Buerkin, of our city, was the architect for our roof.

The foundations were composed of No. 2 street paving brick ($7 per M. delivered), laid in Atlas Portland cement mortar, 1 part cement to 3 parts sand. The foundations, except those at the top of the bank, were 21 ins. thick at base, drawn into 16 ins., and surmounted with a slab of limestone 12 × 12 × 6 ins. A hole ⅞-in. in diameter by 1½ ins. deep, was cut in the center of each stone for a dowel pin ¾ × 3 ins. The cap stones cost 43 cts. each, delivered. It was important that each foundation should be properly located, and a corps of surveyors were kept busy for six days running lines and giving levels. Before removing the stone from the wall for a foundation, the approximate location was given, and when the puddle and earth had been removed stakes were set on north and south and east and west lines, one of them being used as a grade stake. When a depth of 3 to 3½ ft. below the stone wall on the upper side of the opening was reached, and the earth was too soft to receive the brick piers, either concrete or dry stone was rammed in until a good foundation was secured. The puddle was carefully filled in around the piers, when the cement had become hard, and the stone paving relaid.

As the bottom is not quite level, the depth of the piers varied, but the cap stones were laid to uniform level so that 22-ft. posts could be used. The earth under the puddle was firm, showing that the latter was impervious to water.

The lumber used in the construction of the roof was white pine, except the 2 × 6 × 18-in. pieces of oak, which were laid on the top row of piers under the girders. All the dimension stuff was No. 1 common, and the roofing boards No. 2. The posts were dressed, as it was thought best to apply a preservative to prevent decay; they were delivered on the grounds about six weeks before being used, and two coats of Carbolineum Avenarius applied hot with brushes. About one week elapsed between the time of applying the first and second coats, and it was one month from the time the last coat was applied before the water was admitted into the reservoir. The lower ends of the posts were given four coats, and the opening for the dowel was swabbed each time. After the posts were in position a laborer followed the carpenters and applied hot Carbolineum on places that had been bruised. Three barrels, or 150 gallons, were bought, and although it was used liberally, one-half barrel was left, part of which was used for touching the bruised places. As there was over 20,000 sq. ft. of surface covered, one gallon was sufficient for about 165 ft. (two coats on sides and four on lower ends). The expense for material and applying the same was $9.60 per 1,000 sq. ft. of surface. The fumes arising from the hot Carbolineum had no effect on some men, while on others it flushed their faces, which was relieved by applications of cold water. The writer would advise the use of paper masks, goggles and a liberal use of vaseline on hands and faces.

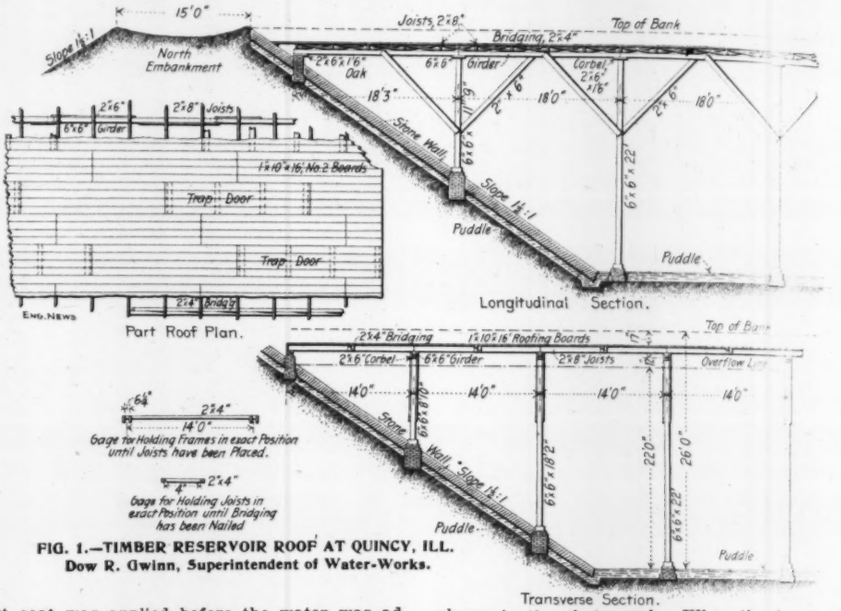


FIG. 1.—TIMBER RESERVOIR ROOF AT QUINCY, ILL.
Dow R. Gwinn, Superintendent of Water-Works.

The fumes arising from the hot Carbolineum had no effect on some men, while on others it flushed their faces, which was relieved by applications of cold water. The writer would advise the use of paper masks, goggles and a liberal use of vaseline on hands and faces.

When about a dozen rows of cap stones were in place the 6 × 6 × 18-in. girders were laid on them (running north and south). A gang of men with cross-cut saws cut them the required length, that is, from center to center of the two cap stones on which they rested. Notwithstanding the fact that every precaution was used to have the cap stones 18 ft. apart, there were slight variations, hence the importance of trimming them on the cap stones over which they would be used. Another gang carried the posts inside and laid them (east and west) at right angles with the girders, the lower ends, into which the dowel pin had been driven, resting against the cap stone of the foundation. Another gang of men made the frames, consisting of two 6-in. posts with the 2 × 6 × 18-in. corbels, 6 × 6-in. × 18-ft. girders, and two 2 × 6-in. × 12-ft. braces. The manner of raising the frames is shown in the photograph. When the frame was vertical, and while it was being held so by the men in the bottom of the reservoir, the men on top dropped their ropes and each took up a 2 × 4-in. timber, about 15 ft. long, on each end of which were nailed 2-in. strips 6¼ ins. apart at right angles with and extending 6 ins. from the sides of the 2 × 4, and engaged the 6-in. girder on the frame just raised, placing the other end over the girder on which they were standing, holding the frame to its place. As the distance from center to center of girders is 14 ft., the strips on the 2 × 4's were adjusted accordingly. Two joists were then pushed out to the girder at each end of the same, laid flat and double and nailed temporarily to give the workmen safe passage to the girder. The erecting gang then passed to the next frame, while two men with ropes drew up the intervening girder, between the frames and nailed the two remaining braces. The joints were adjusted very rapidly by means of gages made of 2 × 4's (see sketch), which also held them firm while the bridging was being nailed. The work of nailing the top boards and making trap doors followed, but it was not necessary to hurry this part of the work, for as soon as the frames were erected, pumping into the reservoir was resumed.

The reservoir was emptied on March 25, and the

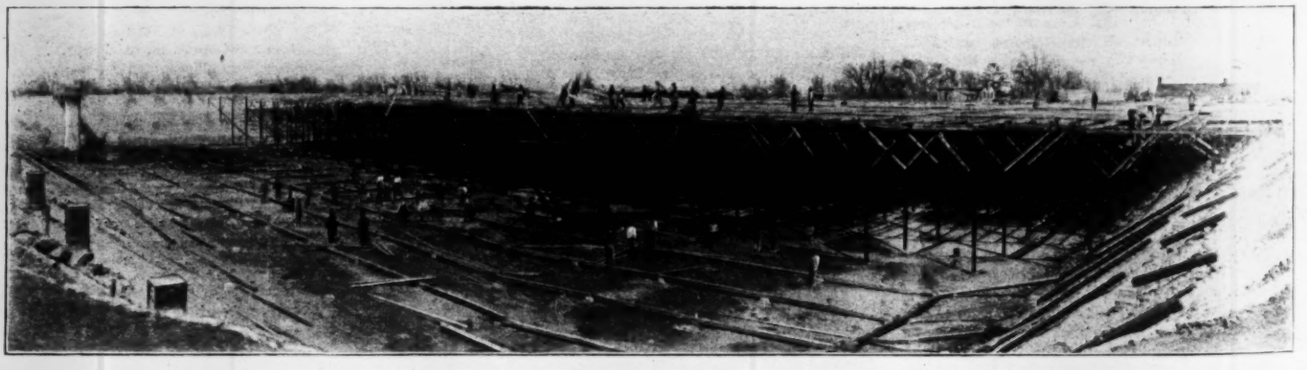


FIG. 2.—VIEW SHOWING RESERVOIR ROOF UNDER CONSTRUCTION.

erection of posts and framework was completed on April 9. Leaving out Sundays and rainy days, there were 12½ days of actual work, when the reservoir could not be used on account of building of the foundations and roof. When the foundations were being built, from 10 to 15 brick masons were employed with a large force of laborers to do the digging and carry the brick and mortar. There were 40 carpenters and assistants. When the erecting gang was familiar with the work, five rows of frames, each 415 ft. in length, were raised in ten hours. The actual cost of the roof, exclusive of foundations and wood preservative, was 4 cts. per sq. ft. of surface covered. This includes the lumber, labor, nails, surveying, stakes, dowel pins and supervision. This figure is on a basis of $15 per M. for the 260,000 ft. of lumber used, and an average price of $1.85 per keg for 8, 10 and 20d. nails, of which 38 kegs were used.

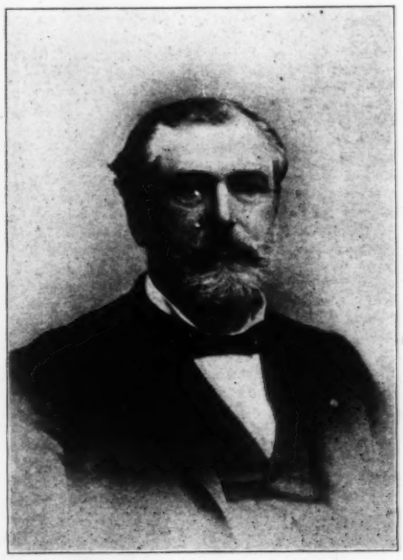
It is very important to have the top boards laid north and south so that the sun's rays will not penetrate through the cracks for any length of time. No. 2 boards were used for covering, but the writer would recommend that No. 1 boards be used if they can be secured at a reasonable price. Of the total roof surface 25% is in trap doors. Our present plan is to open the trap doors when the weather is cool 'n the fall and close them when the thermometer reaches the freezing point, hoping thereby to prevent the formation of heavy ice.

As the roofing boards will warp more or less, we are experimenting on several plans of prevention. The small leakage of sunshine between the boards will not render the roof less effective as a preventative of the vegetable growth, but we wish to keep the interior as warm as possible during the winter, to prevent the formation of heavy ice. If the winter should be extremely cold, we would pump continuously into the reservoir during ice-making weather and when it was full, stop the pumps and supply the city from the reservoir until it was necessary to resume pumping. By this plan of either raising the water or allowing it to fall, the ice would not become attached to the posts sufficiently to do any damage.

CHARLES EDWARD EMERY.

Charles E. Emery, Ph.D., one of the most widely-known of American engineers, died at his home in Brooklyn, N. Y., on June 1, from heart disease, from which he had suffered some years. He was a descendant of an English branch of the Emery family which settled in Newbury, Mass., in 1635. He was born at Aurora, N. Y., on March 29, 1838. He was educated at the Academy at Canandaigua, N. Y., and while at school showed his bent toward mechanical pursuits by reading such works as D. K. Clark's "Locomotive Engineering," and by building model steam engines and boilers. After leaving school he was for a short time in the drafting room of a railroad company, and afterward in a country foundry and machine shop; then he studied law for two years with a view of becoming a patent lawyer, doing also some surveying and map making at odd times. When the civil war broke out in 1861, Mr. Emery was on a sick bed, but soon after he organized a military company, too late, however, for it to be accepted under President Lincoln's first call for troops, and it was disbanded. He then entered the Navy as an assistant engineer, and was on the steamer "Richmond" in the engagement at Fort Pickens, the capture of New Orleans, and the naval attacks at Vicksburg and Port Hudson. After the war, and until Jan. 1, 1869, he was engaged in experimental work for the Navy, under orders from Engineer-in-Chief Isherwood, at the Novelty Iron Works, New York city. Resigning then from the Navy, he remained at the Works making experiments on stationary steam engines, which the Works then proposed to manufacture. The results were afterwards published by Prof. W. P. Trowbridge in a book entitled "Condensing and Non-Condensing Engines." In the fall of 1869 he was general superintendent of the American Institute Fair, which at that time and for a few years afterward acquired some fame in engineering circles through the tests of boilers, engines, etc., which were there conducted.

In the same year he received the appointment of consulting engineer of the U. S. Coast Survey and U. S. Revenue Marine, and he opened an office as consulting engineer and patent expert. He built the Coast Survey steamer "Hassler," and under his direction was constructed the machinery for 20 new vessels for the Revenue Marine, while he repaired and remodeled others. His connection with the Revenue Marine continued until 1891. In 1876 he was one of the judges of the Philadelphia Centennial Exhibition, on engines, pumps and other mechanical appliances. The report of the judges of Group XX was largely his work. The report of the tests of steam boilers, included in it, which tests were made under his supervision, was an important contribution to steam boiler literature. The publications of the results of Mr. Emery's tests of steam vessels and of steam engines, made for the U. S. Navy, and his work as one of the judges at the Centennial Exhibition, gave him an international reputation, and he soon became known as one of the leading steam engineers of the United States. In 1881 he became chief engineer, and later general manager, of the New York Steam Co., a corporation formed for the purpose of distributing steam from a central station in New York city. He designed



Chas. E. Emery

and built the entire plant, providing four stories of boilers, 16,000 HP. in all, at the Greenwich St. Station, and the system of steam piping through the streets, the pipes being of 6, 8 and 10-in. diameter, and extending to distances of about a mile from the station. The station is still running, with the same steam pressure, 85 to 90 lbs., for which it was originally designed. A smaller station, for supplying steam to up-town residences, was erected at 58th St. and Madison Ave. Up to 1887, when Mr. Emery resigned from his position, the steam company had expended nearly $2,000,000.

For the past ten years he was engaged in consulting practice of a most varied character. Much of his work was in connection with litigation in patent cases, condemnation, obstruction and assessment of water power, accident cases, etc. Among the water power cases were those at Holyoke, and Worcester, Mass., Skaneateles, N. Y., Bound Brook and Butler, N. J. He was for some years consulting engineer of the city of Fall River, Mass., and made a report on the difficulties between that city and the mill owners, which resulted in a compromise, the mills agreeing to furnish water to the city from the Watuppa ponds in consideration of the abatement of taxes on water power.

Dr. Emery was a member of the four national engineering societies, of civil, mining, mechanical and electrical engineers, a Fellow of the American Association for the Advancement of Science, and a member of the British Institution of Civil Engineers. He received the Watt medal and the Telford Premium of the Institution for his paper on "The District Distribution of Steam in the United States" (Proc. Inst. C. E., Vol. XCVII., 1889). He was granted the degree of Ph.D. by the University of the City of New York. In 1884 he was a member of the committee of the American Society of Mechanical Engineers, appointed to prepare a code for steam boiler trials, and in 1895 he was made chairman of a committee to revise the code of 1884. Much of the actual work of this committee was done by Dr. Emery, and he was engaged upon the final revision of its report at the time of his death.

He leaves a widow and one son, Mr. Livingston Emery, who is a patent attorney at 99 Nassau St., New York. The funeral services at his residence in Brooklyn were largely attended by members of the various engineering societies.

FOREST STATISTICS FOR THE UNITED STATES, as presented by Mr. B. E. Fernow, Chief of the Division of Forestry in the U. S. Department of Agriculture, show that our annual consumption of timber for industrial purposes is about 40 billion ft. B. M. To meet this consumption there is, says Mr. Fernow, not more than 2,300 billion ft. B. M. of standing timber, or less than 60 years supply. This does not account for firewood or the timber burned in annual forest fires. Of the coniferous growth, the standing supply in the Eastern States will not last more than about 16 years, at the present rate of cut and waste, says the same authority; and the supply on the Pacific coast would not lengthen this period beyond 30 years. The demand is now in excess of the supply, and the conditions call for a cessation of waste and the development of forest culture and general supervision.

THE MINES AND QUARRIES OF THE UNITED Kingdom, says a late Blue-Book, employed 728,713 people in 1897. Of these about 80% were employed underground, and of the surface workers 4,451 were women. The total output of minerals under the Coal Mines Act was 215,145,625 tons, of which 202,119,196 tons were coal—the first time the coal output has passed the 200 million-ton limit. The total output under the Metalliferous Mines Act was 3,783,916 tons, of which 2,216,772 tons were iron ore. Under the Quarries Act 37,378,108 tons were extracted. The death-rate of the underground workers was 1.49 per 1,000 employed; and that of the surface workers was .61 per 1,000 employed. In the coal mines, in 1897, there were 868 separate fatal accidents, causing 930 deaths.

SUMMER MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The 37th meeting of the American Society of Mechanical Engineers was held at the Cataract House, Niagara Falls, N. Y., last week. At the opening session on Tuesday evening, May 31, the Society was formally welcomed to the city by Hon. Arthur Hastings, Mayor of Niagara Falls. Mr. Coleman Sellers, of Philadelphia, the Consulting Engineer of the Cataract Construction Co., explained to the members the principal engineering problems which were met in the design and construction of that company's works, and his address was illustrated by a variety of stereopticon illustrations. Mr. Sellers stated that during the month of March the company's output from their great power station was over 6,000,000 K-W. hours, or an average rate of over 10,000 HP. for every hour of the day and every day in the month.

Referring to the adoption of the 3-phase current for the power plant, he stated that at the time it was adopted few precedents existed for its use at all, and none for its use on so large a scale. It had, however, proved an unqualified success, and had enabled the company to meet the demands of different manufactureres more readily than would have been possible with any less flexible system.

Wednesday, June 1.

At the opening of the first session for the presentation of papers on Wednesday morning, the Secretary announced the result of the last ballot for new members, and stated that the total membership of the Society in all its grades is now 1,887. An amendment to the "Rules," as this Society terms its constitution, was offered, under which an applicant for membership must refer to five members to whom he is personally known, instead of who are "personally known to him," the present wording.

Mr. Gus Henning, for the Committee on Uniform Standards of Tests reported progress, and stated that the committee had just started an experimental furnace at Columbia University, in which the points with relation to the

contraction and expansion of cast-iron brought forward in a recent paper by Mr. W. J. Keep were being verified.

Secretary Hutton stated that it had been the intention of the Council of the Society that the first session of the present meeting should be made a memorial session to the late Sir Henry Bessemer, Honorary Member of the Society, and an invitation had been extended to Mr. Jas. Dredge, of London, to present at such meeting a memorial of Sir Henry. Mr. Dredge has been unable to prepare it, however, in time for the present meeting, and it was presented by title only, and will be later printed in the "Transactions," after it is received from Mr. Dredge.

The first two papers presented both related to the need of standard uniform methods of conducting steam engine tests, one by Mr. Geo. H. Barrus, of Boston, the other by Mr. Bryan Donkin, of London. Mr. Barrus pointed out that the Society has already adopted standards for tests of boilers, locomotives and pumping engines, and urged that it should now formulate a general standard for tests of all classes of engines. His paper also contained suggestions as to what features a standard system should cover.

Mr. Donkin's paper was upon the same general lines, but referred especially to the need for international uniformity in these standards.

Discussions of these two papers were presented by Prof. R. C. Carpenter and Messrs. H. H. Suplee, Jas. B. Stanwood, S. W. Robinson, A. Wells Robinson, F. H. Boyer, C. W. Barnaby and others. The proposed uniform standard system was generally favored, and at the end of the discussion it was voted to recommend to the Council of the Society that a committee of five be appointed to formulate a standard code for the testing of all classes of engines. One member urged, however, that the committee when appointed should bear in mind that the man who paid for the tests had interests which should be considered, and tests should not be made too complicated.

The next paper taken up was by Mr. O. C. Woolson, of New York city, and described a new method of setting an ordinary externally fired shell boiler, so as to permit free expansion and contraction. This paper was rather unmercifully handled in the discussion. Several members criticised the method of setting proposed by Mr. Woolson as complicated and unsatisfactory, and declared that a boiler should be hung up on two points only and left free to expand and contract in whatever direction it desires. Other members expressed the opinion that the whole matter of boiler setting was suffering from over-refinement, and that expansion and contraction had become a sort of bugbear.

The last paper of the morning session was entitled "What is the Heating Surface of a Steam Boiler," by Charles Whiting Baker, of the editorial staff of this journal. It was printed as an editorial in last week's issue of Engineering News. The paper was discussed by Messrs. F. W. Dean, S. W. Robinson, Gus C. Henning, E. D. Meier, H. H. Suplee, Wm. Garrett and others. None of those who took part in the discussion opposed Mr. Baker's principal statement, that the surface exposed to the fire is the heating surface of the boiler, and not the surface exposed to the water, and it was urged that the Committee having in charge the revision of the Society's standard code for boiler tests, should include the correct method of computing heating surface in its report.

The afternoon of Wednesday was spent in excursions by the members to the great power-house of the Niagara Power Co., the works of the Carborundum Co., and those of the Niagara Falls Hydraulic Power & Mfg. Co., in the gorge below the falls. All these establishments have been so fully described in technical literature that no account of them will be attempted here. A reception, dancing and supper at the International Hotel in the evening concluded Wednesday's program.

Thursday, June 2.

The session of Thursday morning was opened with a valuable paper on "Patents," by Mr. Jas. W. See, of Hamilton, O., which was printed nearly in full in Engineering News of last week. Mr. Chas. E. Foster, of Washington, presented a discussion in which he pointed out that a good description is not necessarily a good patent specification. A specification should describe the invention, and not the specific mechanism which the inventor shows in his drawings. If this distinction is kept clearly in mind, the patent can usually be made to cover broadly the invention and protect against infringers. A vast deal has been written on the subject of the wording and construction of claims, but comparatively little upon specifications, and more attention should be given to this branch of the patent solicitor's work.

Mr. A. H. Bates, of Cleveland, O., presented an extended discussion, in which he pointed out, among other things, that by the recent amendment to the patent law a United States patent no longer expires with the earliest expiring foreign patent for the same invention, but continues for its full term. Mr. C. W. Baker advised that inventors and manufacturers should procure complete sets of the patents in which they may be interested. Mr. Ezra Fawcett, of Alliance, O.; Mr. W. W. Varney, of Baltimore, and others also took part in the discussion.

The next paper presented was by Mr. Wm. H. Bryan, of St. Louis, on the "Relations between the Mechanical Engineer, the Manufacturer and the Purchaser of Engineering Materials and Machinery." This paper was published nearly in full in our last issue. Mr. E. D. Meier, in opening the discussion, said that reputable manufacturers would always prefer to deal with a competent mechanical engineer rather than with an architect or with the purchaser direct. In not a few cases architects turn over to the steam-heating contractor the entire responsibility of preparing the heating specification. One objectionable thing in the drawing of specifications is requiring a manufacturer to guarantee results and at the same time tying him up to certain appliances of other manufacturers. For example, a boilermaker should not be required to produce a certain economy and at the same time be required to use a particular furnace with his boiler. Again, materials should be specified by their quality and not by name or brand. It often happens that a manufacturer is required to use a poorer material than is his custom in order to meet the requirement of some specification. Mr. C. W. Barnaby, Superintendent of the Phoenix Iron Works, Meadville, Pa., and Mr. T. W. Hugo, of Duluth, also took part in the discussion.

The next paper was one by Mr. Geo. A. Lowry, of Boston, Mass., entitled "One Hundred Years of Ginning and Baling Cotton." The paper (which we hope to find space for in a later issue) gave an interesting historical account of the inventions relating to the ginning and baling of cotton and closed with a description of a new machine invented by the author for cotton baling, which produces a cylindrical bale with certain valuable advantages over the form of cylindrical bale described in our issue of Nov. 16, 1897. A model of the machine and a full-sized bale of cotton made with it were exhibited in connection with the reading of the paper. The principal advantages of the Lowry machine are that a very small amount of power is required to operate it and the spirally wound layers of the bale spring apart when the bands of the bale are cut, thus greatly facilitating the handling of the cotton at the mills.

Dr. R. H. Thurston's paper on "Graphic Diagrams and Glyptic Models" was the next on the list, and illustrated a variety of cases of the use of plaster relief models to represent quantities depending on three variables in the same way that ordinary plane diagrams are used to represent quantities depending on two variables. There was no discussion on this paper. A paper with the rather misleading title "The Protection of Steam-Heated Surfaces," by Mr. C. L. Norton, of Boston, was the next to be presented. The paper described experiments to determine the relative heat-conducting power of various steam-pipe coverings. The experiments were made by filling a pipe 3 ft. long with oil, heated by an electric resistance coil, and with its temperature kept uniform and constant throughout the test by vigorous stirring, together with sufficient supply of current to just compensate for the heat lost through the covering. At a later date we hope to print some part of this paper. In the discussion upon it Prof. R. C. Carpenter expressed the opinion that the amount of heat given off from an oil-filled pipe and from one filled with steam at the same temperature would be quite different. If this is true Mr. Norton's figures are probably valuable only to show the relative merit of different non-conducting coverings. The paper was also discussed by Mr. H. C. Meyer, Jr., who pointed out that the durability of a material was an important consideration, and by Messrs. Bryan, Suplee, Sweet, Robinson, Gobeille, Gray and others. This concluded the business of the morning session.

The afternoon was spent in one of the most enjoyable excursions in which the Society has ever taken part. The party first walked across the new steel arch bridge, to which the finishing touches are just being given, and at Clifton, on the Canadian side, took the open electric cars of the Niagara Falls Park & River Ry. These carried the party up the Canadian bank of the river close to the Horseshoe Fall and the Canadian Rapids, and thence to the terminus at Chippewa. From there the run was made back by the same route to Clifton and then on down the river across the deep gorge at the Whirlpool Rapids, past the Brock Monument on the heights overlooking Queenston and down the steep grades by which the railway descends the Niagara escarpment to the sleepy little old village of Queenston. A diminutive ferryboat was in waiting here to take the party across the river to Lewiston on the American side, the terminus of the Niagara gorge railway and of the "Old Fort Route" down the river to Youngstown and the old Fort Niagara. The latter road was first taken by the excursionists, and for an hour or more they rode through beautiful orchards extending as far as the eye could reach on either hand. The return journey was made after a brief stop, and from Lewiston the route was over the Niagara gorge railway, a remarkable piece of engineering work. The ride over this line was the most enjoyable part of the whole day's excursion.

Friday, June 3.

At the opening of the concluding session on Friday morning the President announced that news had been received of the death from heart disease of Mr. Chas. E. Emery, one of the charter members of the society, and that a message had been sent to Past President Chas. H. Loring asking him to form a committee of New York members of the society to attend the funeral.

A paper by Mr. Francis J. Cole, Chief Draftsman of the Rogers Locomotive Works at Paterson, N. J., on "Bending Tests of Locomotive Stay Bolts" was then presented. The paper described tests of stay bolts in a machine designed to bend the stay bolt back and forth while it is under tension. It was found that the iron which showed the best results when tested in this way also gave the best results when tested in actual service. Cutting off the threads and reducing the size of the middle of the bolt did not indicate sufficient improvement in prolonging the life of the bolt to justify the extra expense. Study of a large number of tests show that the best results were obtained from an iron having an ultimate tensile strength of 48,000 to 49,500 lbs., with an elongation of 28 to 30% in 8 ins.

In the discussion which followed, a member stated that on Western railways the number of broken stay bolts had been rapidly increasing. On one road records showed three times as many broken stay bolts in 1897 as in 1894. How much of this is due to increased steam pressure and how much to increased bending of the bolt through the use of larger fire-boxes is not known. Recent tests with the "wiggling" machine have shown that a ⅛-in. tell tale hole in the stay bolt reduces considerably the number of vibrations the bolt will stand. A ¼-in. hole reduced the number of vibrations before breakage one-half. The paper was also discussed by Messrs. Henning and Sweet.

A paper by Mr. J. E. Johnson, Jr., Engineer of the Longdale Iron Co., Longdale, Va., on "The Carbon Contents of Piston Rods as Affecting Their Endurance" was then presented. The paper briefly recorded experience with the piston rods of a Vauclain compound locomotive. This showed that a rod of machinery steel ran three years and two months; rods of ordinary iron ran 14 to 15 months; rods of best Swedish iron broke in four months. Rods of high carbon and nickel steel from the Bethlehem Iron Co. are now in use and are expected to have a very long life.

The paper was discussed at considerable length by Messrs. Almond, Suplee, Henning, Sweet, Souther, Robinson and others, the discussion bringing out the fact that where vibrations or bending are to be borne by a piece of metal it should be made of such cross-section that the bending strain will be equally distributed over its length and not concentrated at a single point.

Prof. C. H. Benjamin, of the Case School of Applied Science, Cleveland, O., then presented a paper describing a series of tests to determine the ultimate strength of cast-iron cylinders, such as are used for ordinary stationary engines. We shall reproduce this paper in a later issue. The paper was discussed by Prof. Gray and Mr. H. H. Suplee.

Prof. R. C. Carpenter, of Cornell University, then read a paper on certain aluminum alloys. In the workshops at Sibley College, students have been engaged for some years in making and testing various new alloys of aluminum. Most of these, as was to be expected, proved to have no commercial value. An alloy of 89 copper, 10 aluminum and 1 tin proved a tough, close-grained and highly colored metal of considerable strength and medium ductility. It will be seen that this is nearly the composition of the well-known aluminum bronze, and it does not appear that the slight addition of tin effects any improvement in the metal. The most valuable alloy discovered is one consisting of 2 parts aluminum and 1 part zinc. This metal is well adapted to serve as a substitute for cast brass. It has about the same strength and is as cheap for equal volumes. It takes a high polish, does not tarnish, and is readily worked in lathe or planer. Its specific gravity is about 3.25. Samples of this metal were exhibited, and also samples of an alloy of aluminum and magnesium which showed remarkable lightness, but was so difficult to make that it would probably not be of commercial value.

The last paper was by Prof. Carpenter and Mr. P. J. Fickinger, of the McCool Tube Co., Beaver Falls, Pa., describing the method of manufacture and tests of the McCool tube. This tube is made by drawing down a welded steel pipe in drawing benches of a new and original type. It is claimed that in the finished product no indication of the weld which existed in the original stock is discernible. The tests of a number of samples of these tubes made at Sibley College showed a material of remarkable ductility and toughness.

Mr. Henry Souther, Engineer of Tests of the Pope Tube Co., in discussing the paper said he thought it a mistake to call the McCool tube seamless. If a bad weld existed in the original stock he saw no possible chance for it to be perfected by any process of cold working. Attention was called to the analysis of the steel used as stock for this tube, which showed a higher percentage of phosphorus than would be permitted in a steel rail.

This concluded the technical discussions on the program. Resolutions of thanks were adopted to the various persons, firms and organizations which had contributed to the entertainment of the visitors, and the final adjournment was then taken. Just before the close Secretary Hutton announced that the Council now intend that the summer meeting of 1899 shall be held at Cincinnati. Those of the members who remember the very pleasant meeting in that city in 1890, and the lavish hospitalities which were then enjoyed, will look forward with great pleasure to the next summer meeting of the society.